GEORGIA INSTITUTE OF TECHNOLOGY

OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. ______

Project No. A-3683 GTRI~~XXXX~~ DATE 11 / 9 / 83

Project Director: Phil Potts ~~School~~/Lab TAL-IE

Sponsor: U.S. Agency for International Development
Washington, D.C. 20523

Type Agreement: Contract PDC-1406-I-00-1006-00; Work Order #3.

Award Period: From 9/30/83 To ~~3/15/84~~ 4-14-84 (Performance) ______ (Reports)

Sponsor Amount:

	This Change	Total to Date
Estimated:	$	$ 190,115
Funded:	$	$ 190,115

Cost Sharing Amount: $ ______ Cost Sharing No: ______

Title: Prototype Development and Technical Assistance to the USAID/ Dominican Republic Health Sector II Project.

ADMINISTRATIVE DATA

OCA Contact John W. Burdette ext.4820

1) Sponsor Technical Contact:

Mr. Victor Wehman
S&T/H/WS 702-C-SA-18
Agency for International Development
Washington, D.C. 20523

2) Sponsor Admin/Contractual Matters:

L.E. Stanfield
Agency for International Development
Office of Contracts Management
CM/ROD/ASIA - 733-SA-14
Washington, D.C. 20523

Defense Priority Rating: N/A

Military Security Classification: N/A

(or) Company/Industrial Proprietary: N/A

See notice of Award

RESTRICTIONS

See Attached Gov't Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval — Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with None Proposed.

COMMENTS:

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GEORGIA INSTITUTE OF TECHNOLOGY   OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 10/12/84

Project No. A-3683   ~~School~~/Lab TAL

Includes Subproject No.(s)

Project Director(s) Phillip Potts   GTRI / ~~GIT~~

Sponsor U.S. Agency for International Development

Title Prototype Development and Technical Assistance to the USAID/Dominican Republic Health Sector II Project

Effective Completion Date: 4/14/84 (Performance) 4/14/84 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [x] Final Invoice or Final Fiscal Report
- [x] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other

Continues Project No.   Continued by Project No.

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Form OCA 60:1028

H- 2682

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

November 11, 1983

Mr. Victor Wehman
Office of Health/Science and Technology Bureau
Agency for International Development
U.S. State Department
Washington, D.C. 20523

Dear Vic:

The following is a summary of our first month's (October) activities in providing technical assistance to USAID/Santo Domingo and the Government of the Dominican Republic's Health Sector II Project.

Development of Steel Fabricated Hand Pump with Sealed Bearings. This phase of the technical assistance effort is advancing very well. We are now completing four prototypes of a second-generation design which is essentially the same as that of the first generation pump except that (1) the height of the pump has been increased by approximately 18 inches and (2) guards have been added around the handle's fulcrum points to restrict access of foreign matter (sticks, stones, paper, etc.) into the pump and to prevent accidental injury of hands and fingers when the pump is being operated. The fabrication of the four prototypes should be completed the week of November 7, at which time each will be laboratory tested for at least 24 hours prior to shipment to the Dominican Republic. Present plans are to install the pumps during the first two weeks of December. The pumps will be installed with 2.5 inch galvanized iron pipe (43.45 pesos/20 foot section in quantities of 25 sections or more) and .5 inch plunger rod (32.00 pesos/package of seven sections of rod, each section 20 feet in length), both of which are available from a company in Santo Domingo by the name of Metaldome.

The first generation steel fabricated pump is being laboratory tested on a shallow-well stand (approximately 10 foot head) until a deep-well stand and a simulated head valve can be manufactured. The pump has now finished 180,000 cycles with only one minor problem showing up thus far. The spring which drives the piston during its downward stroke to keep slack out of the chain that connects the plunger rod to the handle broke, either because it was compressed too tightly or its length was too long (or perhaps both). This is obviously a trial and error situation which should not be too difficult to correct. Also, we will not know for sure if the spring is even necessary until we are into field testing of the pump (the weight of the plunger rod may be sufficient by itself to keep the chain taut).

Development of Concrete Water-Sealed Toilet. Very little has been done in developing a concrete water-sealed toilet because of the development of the steel hand pump receiving top priority. However, INCESA Standard has been visisted in Guatemala City. This Guatemala plant was very impressive with competent management and rigid quality control. Here, a ceramic water-sealed toilet was being developed for rural areas which will be introduced to the general public when cost and pricing data have been finalized. INCESA management believes the market for such a product is large.

In the Dominican Republic, SADOSA has donated six ceramic water-sealed toilets to the Secretariat of Health for installation in the field. Six sites chosen for these toilets were recently visited by Georgia Tech project personnel. Three of the sites had been completed, were being kept clean by the villagers, were being used by the villagers, and were completely free of any offensive odors. The remaining three sites had the toilets installed but sheds had not been constructed over them at the time. Selling price of the SADOSA toilets has not yet been ascertained.

Development of Tripod for Steel Hand Pump Installation. As mentioned previously, we will be installing several steel hand pumps in the Dominican Republic during the first two weeks in December. Ben James, who is now in Haiti, will spend the week of November 14 investigating the capabilities of Dominican Republic foundries and machine shops. He also will work with one of these machine shops in fabricating a tripod for the installation of the steel pumps in December.

Technical Assistance to AID Hand Pump (Cast Iron) Manufacturers and the Government of the Dominican Republic. Approximately 940 AID hand pumps of the traditional design or of the modified design (PVC drop pipe and cylinder) are installed in the field. The majority of these pumps have substandard cap assemblies (cap, handle, handle fulcrum, rod end, sliding blocks, pins and bushings) with loose bushings and insufficiently hardened pins and bushings being the most noticeable sign of poor quality. We also know from previous experience that the plungers (pistons) do not hold up well because of dimensional inadequacies. In some cases the plunger rod has broken at the rod end because of poor machining that later caused overstressing of the plunger rod (the drilled and threaded hole in the rod end was machined at a very slight angle which caused the plunger rod to be flexed at an angle rather than moving up and down on a straight path). Some of the pumps still have leather foot valves.

We have recommended to USAID/Santo Domingo and the Government of the Dominican Republic that the cap assemblies and plungers which are a part of the pumps installed in the field be replaced with components meeting proven specifications. Unfortunately, because of time constraints, we cannot see this recommendation through to completion because it necessitates a foundry/machine shop manufacturing the required number of parts under Georgia Tech technical assistance, Georgia Tech project personnel approving production of the parts in comparison with specifications, the Government of the Dominican Republic disbursing the parts to rural health centers for eventual replacement on pumps installed in the villages, and extensive field training of health educators and village caretakers in installation, maintennace and repair. Fortunately, if a timely decision is made on this recommendation, we can provide initial technical assistance in all areas. The amount of technical assistance will depend on when, and if, the decision is made to proceed with the implementation of the recommendation.

Technical assistance is also planned to improve the installation techniques of the AID modified pump (with PVC drop pipe and cylinder). By the end of the project, at the latest, a clear decision should be possible as to whether future production of hand pumps should be of the original design of the AID hand pump, the modified version or the steel fabricated pump. We should mention at this point that we hope to have a limited number of the steel pumps produced in the Dominican Republic for a more accurate analysis of their manufacturing costs (USAID/Santo Domingo is of the opinion this can be done without competitive bidding). If the steel pumps are produced locally, their manufacture should be carried out in January (1984).

We also began analyzing the capabilities of foundry/machine shops in October. Thus far six companies have been visited in the Santo Domingo area for possible future manufacture of hand pumps (cast iron or steel). The analysis of these six companies plus others, if identified, will be completed the week of November 14 by Ben James.

<u>Assessment of Status of Health Sector II Project</u>. Henry Van has completed the workshops under Work Order #2 of our IQC. While conducting these workshops he was able to gather the following information:

- Hand pumps that have been installed continue to frequently breakdown. Reports show that only two weeks after installation some hand pumps fail to operate properly.

- Of the 26,500 latrines to be installed, only about 9,000 have been constructed. The concrete slab and seat have been made by two private contractors. These contractors are not producing good quality slabs and seats and, upon completion of their contracts (Nov. 1983), SESPAS will not renew them. Instead, SESPAS will look for other contractors.

- The training given to the health educators since April 1983 on latrine construction, hand pump installation, maintenance and repair, and health education has helped the project considerably. The individuals that received the above training are now very active in promoting community participation, training villagers in the maintenance and repair of the hand pumps, and installing latrines. However, much more training remains to be conducted before a significant improvement is actually noticed. Both SESPAS and the USAID/Mission in Santo Domingo feel that this training is doing a lot of good.

- o The water well drilling program is continuing with INAPA selecting drilling sites and supervising private drilling contractors in the drilling operations. Between January and August 1983, 206 wells were drilled with an average depth of 87 feet. INAPA'a contract was signed on April 23, 1983 and field activities began the second week of May 1983.

  Before INAPA's contract, SESPAS was doing site selection for the well drilling as well as supervising the drilling operation. SESPAS was having over 30% reject wells. We have been informally told that the situation has improved, but not as much as everyone expected.

USAID/DR and SESPAS, we should mention, have been very cooperative and have expressed their interest in working closely with us to resolve problems in the project. The following are activities which USAID/DR and SESPAS feel are important and we should provide technical assistance to carry them out.

- o Organize short (1-3 days) hand pump installation, maintenance and repair workshops in each of the four project unit areas (see attached map). Health educators already trained during the past hand pump workshop will be asked to give the training with the supervision of GIT personnel. The hand pump training manual developed under Work Order No. 2 will be used by the health educators.

- o Assist in development of at least one prototype of the health education flipchart similar to the one currently used in Honduras. This flipchart has been modified to suit the Dominican culture prevailing in the project area. This modification was done during the Health Education Workshop conducted October 24-28, 1983.

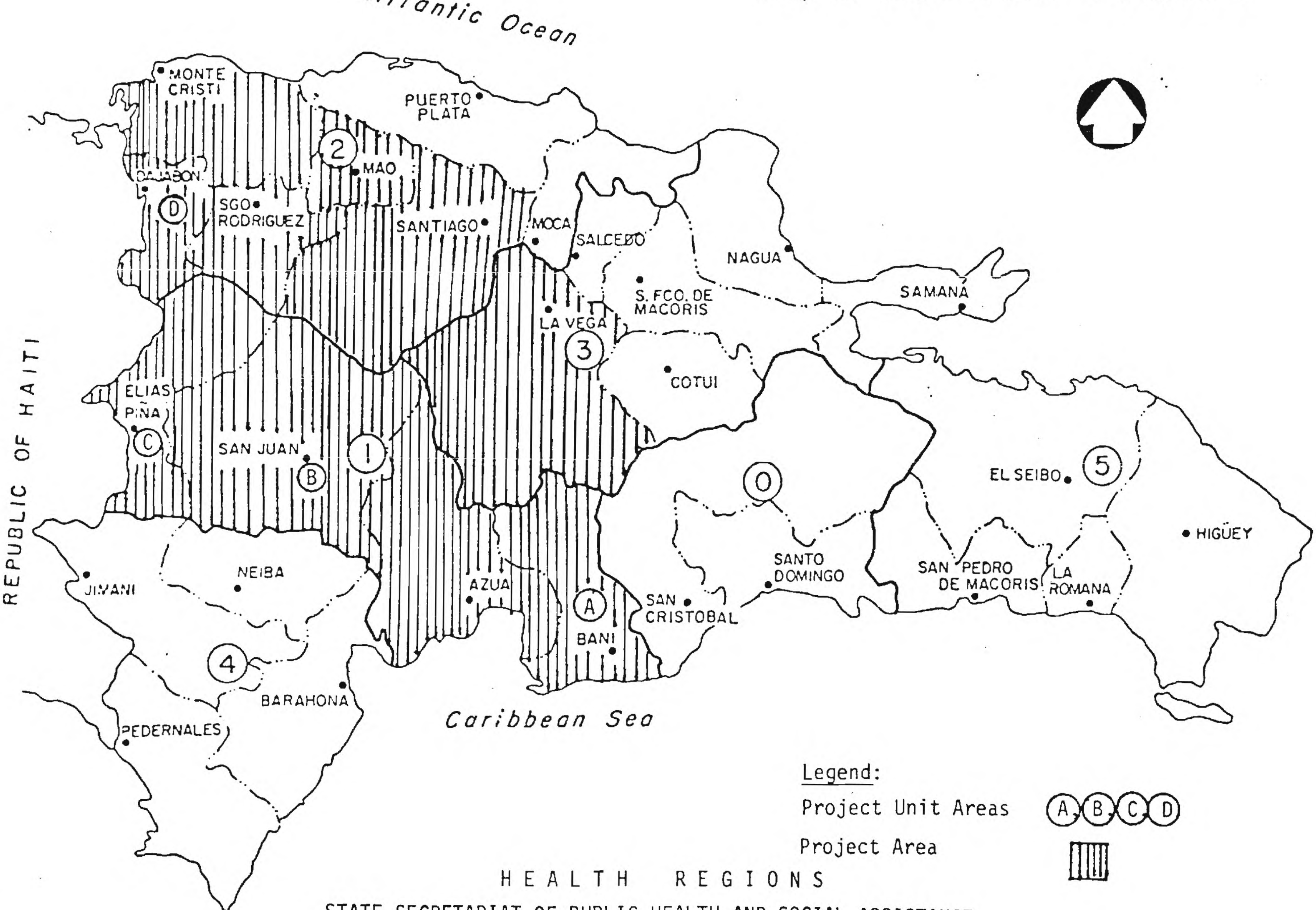
- o Assist in conducting an inventory of the exact number of hand pumps installed and those that are not operating. This activity will help us gather the required information to design the hand pump repairing strategies.

- o Review design and specifications for the latrine concrete slabs and hand pump concrete apron. To date, the project has had considerable breakage and cracking of the concrete from both of the above units. At this point, we feel that most of these problems are caused by poor quality control.

- o Design system for installation and maintenance of hand pumps and latrines.

- o Development of on-going training that is practical and product-oriented. At this point the possibility of incorporating the Health Sector II project into a Government Agency Program is very low according to USAID/DR. Therefore, the training program to be designed

Map of the Dominican Republic



HEALTH REGIONS

STATE SECRETARIAT OF PUBLIC HEALTH AND SOCIAL ASSISTANCE must be realistic in that the project only has two more years to completion. Efforts should be directed toward the training of villagers to maintain and repair the hand pumps.

In closing, we look forward to your return to the United States. If at all possible, we would welcome an open discussion with you before Henry Van returns to the Dominican Republic November 21, 1983.

Yours truly,

Phillip W. Potts
Technology Applications Laboratory

PWP/lbh

GIT Project A-3683

PROTOTYPE DEVELOPMENT AND TECHNICAL ASSISTANCE FOR THE USAID/DOMINICAN REPUBLIC HEALTH SECTOR II PROJECT

Prepared for
The U.S. Agency for International Development
under Contract No. PDC-1406-I-00-1006-00
Work Order No. 3

by

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GEORGIA INSTITUTE OF TECHNOLOGY
Atlanta, Georgia
April 1984

TABLE OF CONTENTS

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

This program of prototype development and technical assistance would never have succeeded without the help of many individuals who have supplied large quantities of information and have given freely of their time, permitting project personnel to profit from their seasoned judgment. This program did not contractually require active participation by the USAID Mission in the Dominican Republic, but assistance was given abundantly in the form of personnel, coordination of program activities, and interest and insight into local conditions within the Dominican Republic. Personnel of the State Secretariat of Public Health and Social Assistance (SESPAS) contributed significantly with their own resources of vehicles, tools, office space, and employees possessing noteworthy technical skills, dedication, and professionalism.

While it is impossible to list all individuals who have rendered assistance to the program, the authors of this report would like to acknowledge with a note of appreciation Dr. Oscar Rivera-Rivera, Mr. John Henry Thomas and Mr. Manuel Valdez of the USAID Mission and Dr. Jose M. Herrera Gabral of SESPAS.

EXECUTIVE SUMMARY

On September 30, 1983, the USAID Office of Health, Bureau for Science and Technology, in Washington, D.C. awarded IQC No. PDC-1406-I-00-1006 Work Order No. 3 to Georgia Tech. The major tasks of Work Order No. 3, as described in this report, were to:

1. Develop, assist in manufacturing, and field test in the Dominican Republic a steel-fabricated hand-operated water pump with sealed bearings, a hand pump installation tripod, and a water-seal toilet, as appropriate to local requirements.

2. Investigate the feasibility of local manufacture of cast iron AID hand pumps, steel pumps with sealed bearings, installation tripods, and water-seal toilets in the Dominican Republic. This included the provision of technical assistance to manufacturers in the production of high quality hand pumps (cast iron AID design or steel design with sealed bearings), installation tripods, and water-seal toilets, as requested by USAID/Dominican Republic.

3. Augment existing training to the Health Sector II Project in the Dominican Republic.

In addition, the status of the Health Sector II Project was determined during the initial stages of Work Order No. 3 (on verbal instructions from AID/Washington's Office of Health) in order to establish the proper context for project activities. The status investigation covered the administrative structure of the State Secretariat of Public Health and Social Assistance (SESPAS); initiation and completion dates for the Health Sector II Project; well drilling; hand pumps (manufacturing, installation, and maintenance and repair); spring-capped, gravity-fed water systems; excreta disposal systems (manufacturing, installation, maintenance and repair); and health education (training and training materials development).

In response to the first task, a steel-fabricated hand pump design was developed further from a prototype by Georgia Tech engineers. The pump features minimal moving parts and sealed ball bearings to reduce the incidence of pump failure caused by lack of lubrication. In addition, the design includes underground pump components that allow piston withdrawal through the drop pipe and changing of leather cups without having to remove the pump base or drop pipe.

Four of the steel pumps were manufactured at Georgia Tech's machine shop and shipped to the Dominican Republic in November 1983 for installation and field testing. In December 1983 and January 1984, 12 steel pumps were manufactured in the Dominican Republic. Ten of these pumps were installed for field testing during the latter part of January and the early part of February 1984, and a high level of community acceptance has been reported. In all installations, the pumps could be operated by women and children, though the pump at one site (Haina) was fitted with a longer handle for improved mechanical advantage.

Only minor installation, design, and manufacturing problems occurred during the pump's development, and the steel pumps have performed for several months in the field in conformance with design criteria. However, the pumps being tested in the field should be removed from the wells and all components closely inspected to complete the initial evaluation of their performance. From these inspections, a valid recommendation can be made on whether the steel hand pump design is appropriate for further installation in the Dominican Republic.

Georgia Tech has developed design concepts for a concrete water-seal toilet which could be easily manufactured in a developing country, and a company in the Dominican Republic, Sanitarios Dominicanos, S.A. (SADOSA), produced six ceramic water-seal toilets which were given to SESPAS for installation in the Health Sector II project area. Users of the test samples have reported that the water-seal toilets are much nicer (no offensive odors) than pit latrines; however, they require between one and two gallons of water for flushing. The USAID Mission has followed up on the performance of the toilets and reports that they have a tendency to become clogged with rocks and corn cobs used by villagers for cleaning purposes. For this reason, the USAID Mission prefers to stay with pit latrines for the Health Sector II Project.

A final tripod design was completed by Georgia Tech in November 1983 and one prototype was manufactured in the Dominican Republic in December 1983. It was then used to install or remove over 25 pumps. This tripod design can be erected by three men in less than 15 minutes. It is also easily transported. It was carried from site to site in a Datsun short-bed pickup truck with less than 3 feet extending beyond the truck bed. The safety of this triopod, when properly used, was evidenced by the over 25 accident-free pump installations and removals. It is also easily manufactured in unsophisticated machine and welding shops.

To accomplish the second task of the work order, ten companies in the Dominican Republic were investigated to determine their capability to manufacture the AID-design hand pump (cast iron). Only one of these companies, Cedeno Industrial, S.A., had both foundry and machine shop facilities and the potential for producing a quality AID hand pump in significant quantities.

Four machine shops were evaluated for their capabilities to manufacture the steel pump. Three of these were determined capable of producing a quality steel pump at a competitive price.

In addressing the third major task of the work order, training was given between October 1983 and February 1984 in latrine construction; hand pump installation, maintenance and repair; and rural water supply, basic sanitation, and food hygiene.

Such training must continue if the Health Sector II Project is to conclude successfully. Not only do existing SESPAS staff, health committee members, and village caretakers need their training reinforced, but also new health educators who will be hired in the future to assist with expanded duties will require training.

Moreover, a system for installing and maintaining hand pumps and latrines should be developed in order to take advantage of the very positive aspects of the recent training in the Dominican Republic. The recommended system is designed to avoid past mistakes and incorporates those ideas proven successful in the field. In general, health educators should be responsible for obtaining community participation, aided by use of prominently displayed posters and a field flipchart prepared by SESPAS. Training of the communities in latrine construction and hand pump installation, maintenance and repair should continue to be performed in the field by health educators. For this reason, continued adequate training of health educators is important. Tools required to install and repair hand pumps must be purchased. Availability of transportation, for instance, pickup trucks, must be improved to transport tripods, latrine components, hand pumps, rod, pipe, and tools. Spare parts also must be made available to the communities.

It must be recognized, however, that such a program should start slowly, gradually accelerating as health educators become more proficient in training, thus transferring the technology to new health educators and communities. The system is dependent, also, on health educators and village caretakers with sufficient expertise and confidence. So far, field observations by Georgia Tech clearly indicate that with sufficient training and assistance, communities have the potential for becoming largely self-sufficient in terms of repair and maintenance.

1. BACKGROUND

Health Sector II Project

In August 1978 the U.S. Agency for International Development (USAID) approved the Health Sector II Project of the Government of the Dominican Republic for bilateral assistance. The Healtn Sector II Project is a continuation of efforts initiated under a Health Sector I Project in 1975. The goal was to improve the health status of rural inhabitants of the Dominican Republic in two of six health regions. The State Secretariat of Public Health and Social Assistance (SESPAS) selected Health Regions 1 and 2 as those two regions (see Figure 1).

To reach this goal, the project agreement specified the following objectives:

Water Systems

- Construct approximately 2,600 new drilled water wells and equip them with hand-operated water pumps.

- Construct gravity-fed water systems (aqueducts) when the use of hand pumps is not feasible.

- Provide water storage containers to each family served by either hand pump or gravity-fed water systems.

Excreta Disposal Systems

- Construct 22,500 simple pit latrines.

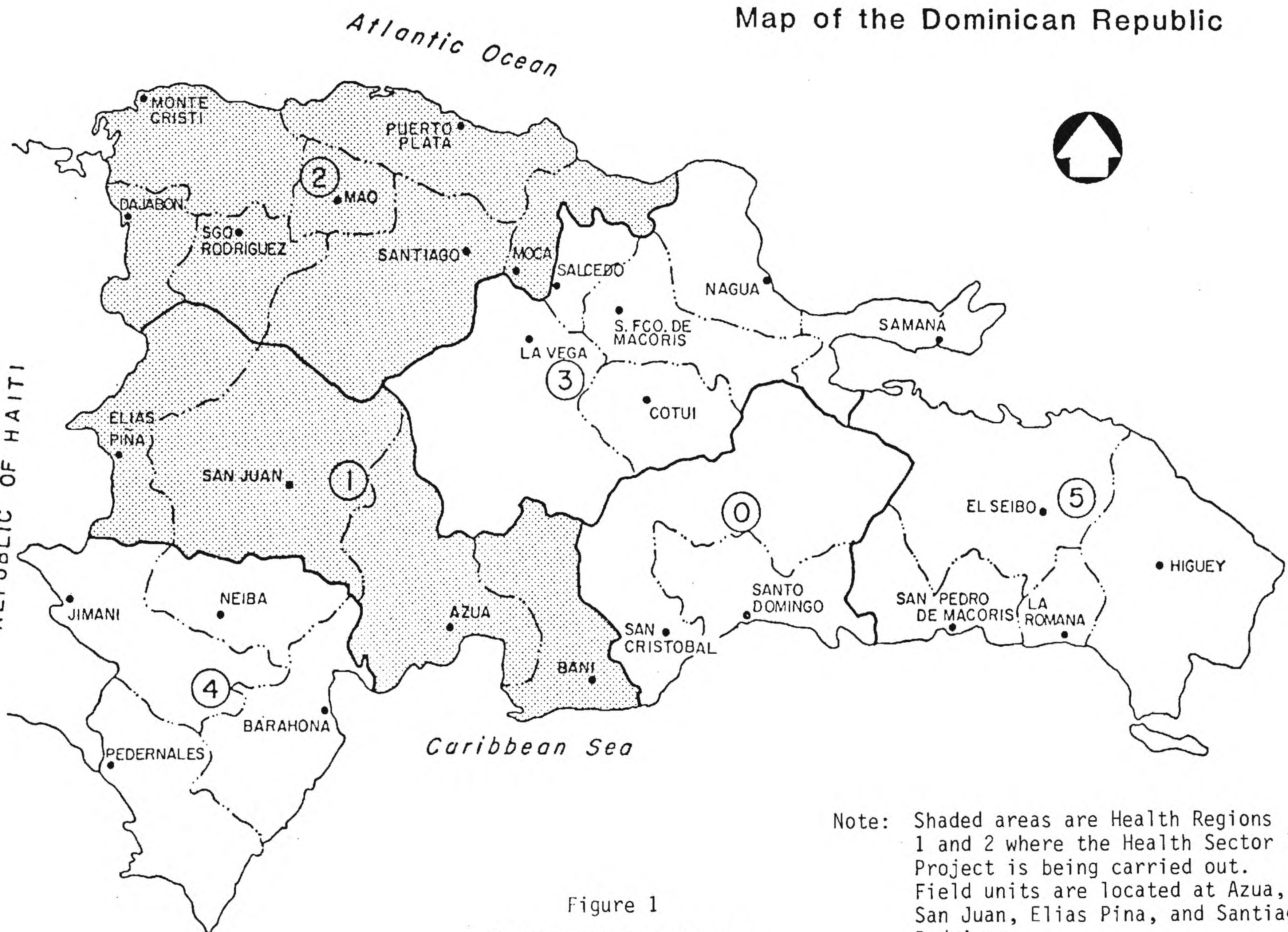


Figure 1

HEALTH REGIONS

Note: Shaded areas are Health Regions 1 and 2 where the Health Sector II Project is being carried out. Field units are located at Azua, San Juan, Elias Pina, and Santiago Rodriguez.

Health Education

- Provide health education to the communities within the project area on the relationship of water and sanitation to health.

Development of Local Capability to Manufacture AID Hand Pumps

Georgia Tech's involvement in the Dominican Republic began in early 1978, prior to Health Sector II, with an investigation into the feasibility of locally manufacturing the AID hand pump (see Figures 2 and 3). The feasibility study showed that:

o the level of machine shop and foundry skills existed to produce the AID hand pump,

o the price of large quantity orders would be competitive in the world market, and

o the Dominican Republic had substantial areas where hand pumps were more appropriate than other available means for developing water sources.

A contract was signed in August 1978, between USAID/Dominican Republic and Georgia Tech, which was implemented between August 1, 1978, and June 30, 1979. The objective of this project was to develop a local capability to manufacture the AID hand pump and to field test it under existing rural conditions. The USAID Mission was especially interested in the project because it was, at the time, negotiating the Health Sector II loan agreement. Local manufacture of the hand pumps for Health Sector II was particularly attractive for more timely and more convenient availability of spare parts, generation of local employment, and potentially lower prices over imported pumps of comparable quality and durability.

Two local machine shop/foundries (INDUSTROQUEL and Astilleros Navales Dominicanos) were contracted to produce 12 shallow-well and 12 deep-well

AID HAND–OPERATED WATER PUMP
DEEP WELL

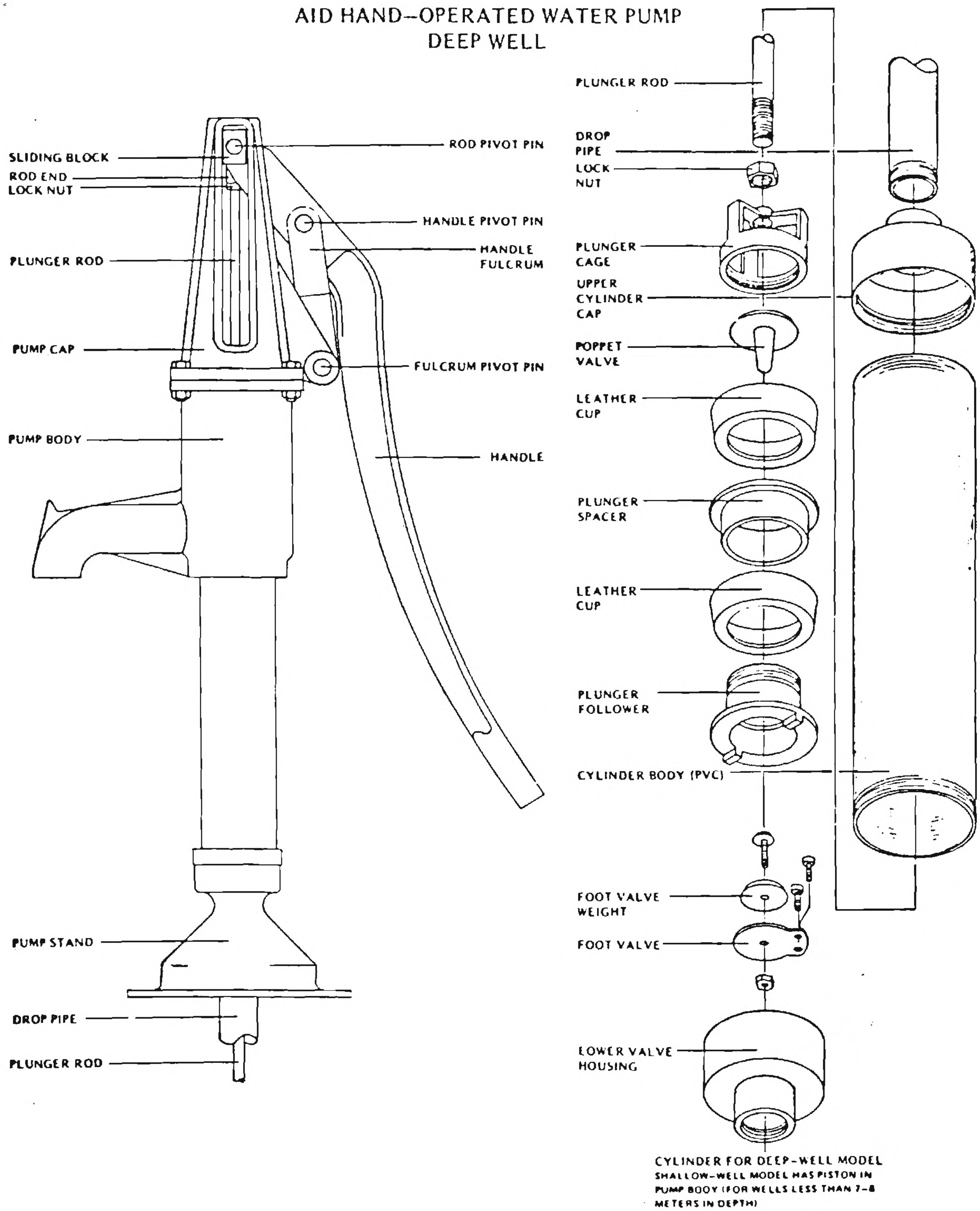


Figure 2

AID HAND–OPERATED WATER PUMP
SHALLOW WELL

(For Wells less than 7-8 meters in depth)

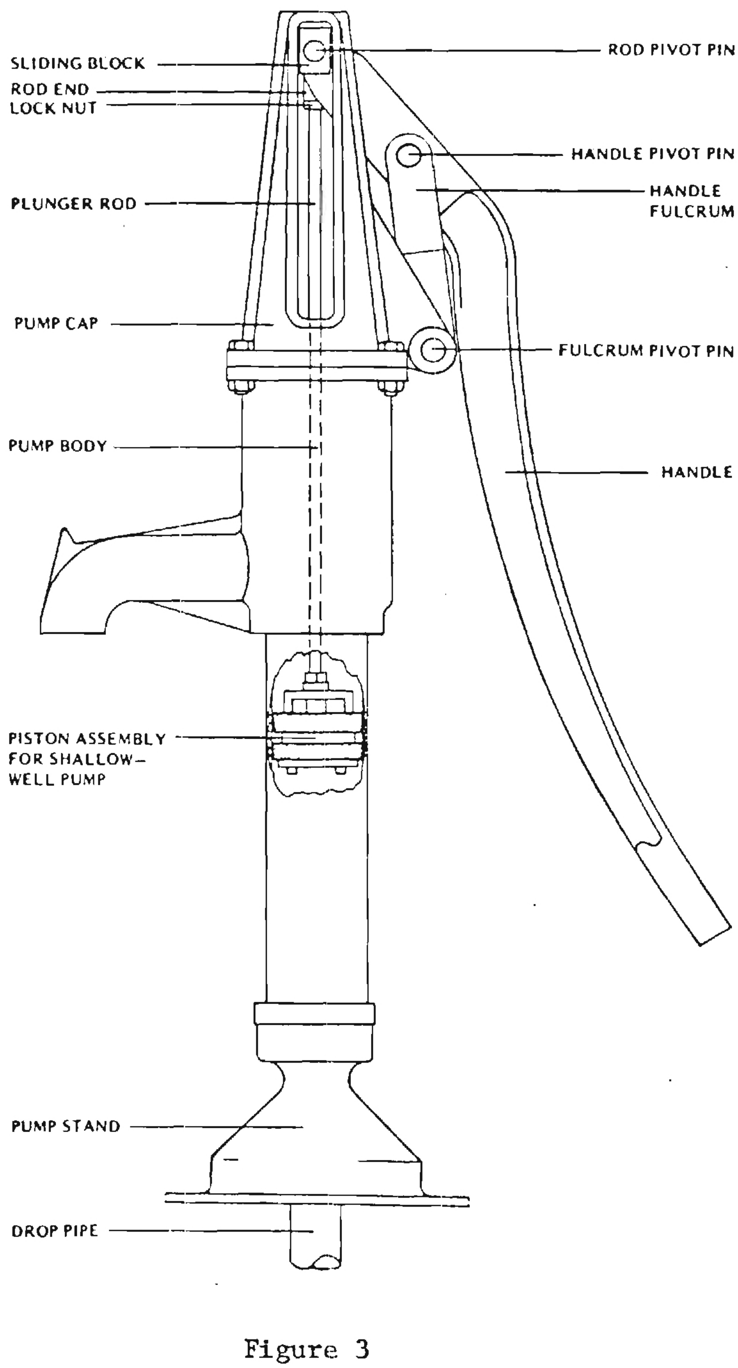


Figure 3

AID hand pumps each. The 24 pumps were manufactured, then inspected and received by Georgia Tech project personnel between late November 1978 and early January 1979. Of the 24 pumps, 21 were installed in the Cibao Valley of the Dominican Republic, near Santiago. The remaining three pumps were used to provide spare parts.

The test pumps functioned well in the field even though they contained manufacturing deficiencies, especially in conforming to dimensional tolerances. (This resulted in some components fitting too loosely while others fit too tightly). Twenty-two additional pumps were later manufactured with significant improvements in quality and shipped to other countries as prototypes. Georgia Tech's involvement in the Dominican Republic then ended with a one-week training workshop in January 1979 for Santiago hospital technicians in water quality analysis.

As previously mentioned, INDUSTROQUEL and Astilleros Navales Dominicanos received the initial technical assistance from Georgia Tech to establish AID hand pump manufacturing capabilities in the Dominican Republic. However, through competitive bidding, Equipo Tecnico Industrial, C. por A., (ETINCA) was awarded the contract in March 1980 for the first 1,000 hand pumps to be used in the Health Sector II Project. Technical assistance was later provided through Orders of Technical Direction (OTD) Nos. 1 and 48 to ETINCA by the Water and Sanitation for Health (WASH) Project, a USAID/Washington centrally-funded program operated by Camp Dresser and McKee (CDM). CDM, in turn, assigned the technical assistance effort to a consultant for the International Science and Technology Institute (ISTI) who had previously assisted Georgia Tech on other AID hand pump programs in Tunisia, the Philippines, Honduras, and Ecuador.

Technical/Management Review of the Dominican Republic AID Hand Pump Program

In September 1982 Georgia Tech was assigned the task of providing a senior international hand pump expert to serve as a member of a technical/management team to review AID hand pump programs in Sri Lanka, the Philippines, Indonesia, Honduras, the Dominican Republic, and Haiti. The AID hand pump program was not going well in the Dominican Republic. Although hand pumps of the traditional AID design were still functioning, a modified version of the AID hand pump featuring a plastic foot valve and two-inch PVC (polyvinyl chloride) drop pipe had a failure rate of nearly 50 percent after several weeks of use. The review team recommended that a thorough field investigation be conducted to determine the causes of failure and to pinpoint a corrective course of action.

Follow-Up to Technical/Management Review of the Dominican Republic Hand Pump Program

On March 7, 1983, the USAID/Washington Office of Health, Bureau for Science and Technology, issued OTD No. 143. This OTD resulted from a training needs assessment performed under the WASH Project that had identified problems with slabs cracking due to improper mixing of concrete and with unusually slow progress in constructing latrines. In response to recommendations, OTD No. 143 requested the WASH Project to plan and implement two workshops on latrine construction for SESPAS personnel. (The workshop activities were subcontracted to Georgia Tech and successfully carried out April 4 through April 16 and April 25 through May 6, as originally planned.)

This OTD was amended March 17, 1983, to include a field survey, inspection, and analysis of the modified AID hand pump failures occurring in the Dominican Republic. These activities were also subcontracted to Georgia Tech.

Georgia Tech found four prevalent problems, as described in WASH Field Report No. 98:

(1) a combination of design modifications, manufacturing faults, and installation flaws allowing foreign matter to interfere with the normal operation of the piston (plunger) poppet valve and the foot valve poppet,

(2) plunger poppet valve failure,

(3) separation of the PVC pipe assembly, and

(4) separation of the plunger rod.

Georgia Tech recommended three alternatives:

(1) Tighten criteria for the selection of a manufacturer to produce pumps in the future,

(2) Change the pump design and materials, or

(3) Provide concentrated technical assistance and training to the manufacturer and to those responsible for implementing the hand pump program.

Further Training Assistance to the Health Sector II Project

In the summer of 1983, the first step was taken to follow through on Georgia Tech's recommendations. USAID/Dominican Republic requested USAID/Washington to provide technical assistance to SESPAS for three training workshops. The three one-week workshops were presented in October 1983 under Georgia Tech's Indefinite Quantity Contract (IQC) PDC-1406-I-00-1006 Work Order No. 2. The workshops are described below:

1. Hand pump installation, maintenance, and repair--The objective here was to train health educators in the installation, maintenance, and repair of hand pumps so that they would be able to diagnose hand pump operational problems and make necessary repairs.

2. Latrine construction--This workshop for health educators was designed to meet an immediate project need to increase the quantity and improve the quality of latrine construction. Emphasis was also on optimizing

latrine site selection to prevent water source contamination, especially in community water wells.

3. Rural water supply, basic sanitation, and food hygiene--The focus of this workshop was on training project health personnel in health education methods appropriate to their education level and immediate project needs. The training also included information on basic data collection methods, identification of community health needs, strategies for influencing community health participation, and development and use of health education materials.

In addition to improving technical skills, the health educators developed training and communication skills. This enabled the health educators, in turn, to provide training for community workers in construction, installation, maintenance, and repair of their hand pumps and latrines. As a result of these workshops, health educators have gradually assumed responsibility for hand pump and latrine maintenance and repair, eliminating the need for SESPAS to work with private contractors.

Development of Steel Hand Pumps with Sealed Bearings, Installation Tripods, and Concrete Water-Seal Toilets

Independently of the AID program, Georgia Tech engineers, using Georgia Tech's internal research funds, developed a steel hand pump with sealed bearings, a hand pump installation tripod, and a concrete water-seal toilet. The hand pump uses simple machining and welding techniques to avoid the more complicated casting and machining requirements of the AID cast iron pump. In addition, sealed bearings eliminate the need for lubrication in the field. The tripod is capable of being manufactured locally and makes pump installation easier and safer. The concrete water-seal toilet meets a need in developing countries where ceramic toilets are either too expensive or not available.

Even though the steel hand pump, the tripod, and the water-seal toilet designs showed a high level of potential for local manufacture and use in developing countries, a complete evaluation would require field testing. The Dominican Republic seemed especially appropriate for the field testing because of its problems with hand pumps and latrines.

Scope of Work

On September 30, 1983, the USAID Office of Health, Bureau for Science and Technology, in Washington, D.C. awarded IQC No. PDC-1406-I-00-1006 Work Order No. 3 to Georgia Tech. The major assignments of Work Order No. 3 were to:

- further develop, manufacture, and field test in the Dominican Republic the steel pump with sealed bearings, the installation tripod, and the water-seal toilet.
- investigate the feasibility of future local manufacture of cast iron AID hand pumps, steel pumps with sealed bearings, installation tripods, and water-seal toilets in the Dominican Republic. This included the provision of technical assistance to organizations as requested by USAID/Dominican Republic in the production of high quality hand pumps (cast iron AID design or steel design with sealed bearings), installation tripods, and water-seal toilets.
- augment existing training of the Health Sector II Project in the Dominican Republic.

In addition, to the above tasks, Georgia Tech received verbal instructions from AID/Washington's Office of Health during the first week of October 1983 to gather information that would indicate the current status of the Health Sector II Project. If the status indicated a need for modifying the scope of work of Work Order No. 3, Georgia Tech was instructed to immediately notify the Office of Health.

Work began on October 1, 1983, and was completed on April 15, 1984 without any modifications to the scope of work. This report is based on results of the work conducted under Work Order No. 3, discussions with the people directly involved in the Health Sector II Project both in Santo Domingo and in the project area, and on a review of background documents. Chapter 2 presents the status of the Health Sector II Project as of October 1983. Chapter 3 covers activities relating to developing, manufacturing, and field testing of the steel pump, the installation tripod, and the water-seal toilet as well as the feasibility of future local manufacture of the installation tripod and water-seal toilet. Chapter 4 discusses the results of investigating the feasibility of locally manufacturing cast iron AID hand pumps and the steel pump with sealed bearings. Chapter 5 is a description of the training conducted under this work order and an assessment of further training needs. Chapter 6 is a recommended approach to installation and maintenance for hand pumps and latrines.

2. STATUS OF THE HEALTH SECTOR II PROJECT

The status of the Health Sector II Project as of October 1983 was determined during November and December by Georgia Tech engineers in order to establish the proper context for project activities. That status is detailed below, and covers the administrative structure of SESPAS, initiation and completion dates for the Health Sector II Project, well drilling, hand pumps (manufacturing, installation, and maintenance and repair), spring-capped, gravity-fed water systems, excreta disposal systems (manufacturing, installation, maintenance and repair), and health education (training and training materials development).

Administrative Structure

The Health Sector II Project is administered by a central coordination office and four field units. The central coordination office, located in Santo Domingo, reports directly to the Secretary of Health. It is responsible for developing project implementation plans, coordinating activities, and reviewing progress and problems in implementation of the project. This office, managed by a project coordinator, also makes all decisions concerning proper allocation of personnel, equipment, and financial resources at each project stage.

Field unit heads in Azua, San Juan de la Maguana, Elias Pina, and Santiago Rodriguez oversee and coordinate all field activities. In the two larger field units (San Juan de la Maguana and Santiago Rodriguez), unit heads directly supervise one or two unit supervisors, who in turn oversee and coordinate health educators/promoters in their areas. In the two smaller areas (Azua and Elias Pina), unit heads supervise the educators/promoters themselves.

At the beginning of the project, an engineering group of six civil engineers was established in the city of Azua to provide technical support for the project. Due to inefficient performance, these engineers were discharged. Later, two civil engineers were hired to provide technical assistance. Since November 1983, the project has had only one field civil engineer, who is in charge of water well site selection.

Installation of hand pumps and construction of latrines have been assigned to private contractors. In addition, SESPAS employs a hand pump maintenance crew, which repairs hand pumps throughout the project area.

Local management of the potable water and excreta disposal systems is the responsibility of community health committees. Each volunteer committee collects funds from community members for routine hand pump maintenance and collaborates with the local health educators.

Health educators promote the program in their assigned communities and provide health education to community members. Since 1983, health educators are gradually becoming responsible for training villagers in the construction, installation, and maintenance of latrines and in the installation, maintenance, and repair of hand pumps.

Schedule

The project agreement for Health Sector II was signed in November 1978, with a completion date of November 1983. Because the problems discussed below have delayed completion, the project was awarded an extension with a new completion date of November 1985.

Water Well Drilling

At the onset of the project, SESPAS held responsibility for both site selection and the selection and management of well drillers. Site selection was performed by a civil engineer. Due to the high percentage of dry wells drilled, SESPAS agreed to contract with the National Institute of Aqueducts and Sewers (INAPA), a government agency charged with the design and construction of all government-funded potable water supply and sewer systems. INAPA was contracted to drill 105,000 feet of wells. In accordance with the INAPA/SESPAS contract signed in June 1983, INAPA is now responsible for both site selection and well driller selection and management. SESPAS is responsible only for coordination.

SESPAS engineers have reported the following problems with this drilling contract:

- The percentage of dry wells has been reduced only marginally.

- There has been an excessive use of steel rather than PVC casing because contractors make more money using steel casing.

- A shortage of manpower within INAPA has caused delays. INAPA's hydrogeology division is composed of only three individuals (two engineers and one hydrogeologist), who are responsible for different projects in other parts of the country as well.

- Lack of adequate coordination between INAPA and SESPAS has caused confusion. In some cases, communities are promised wells but do not get them; in other cases, the well drillers begin work before their presence is properly explained to the communities.

Table 1 shows the status of water and dry wells from 1980 through 1983. Average depth of the water wells drilled is 85 feet.

Hand Pumps

Three types of hand pumps using the USAID design have been manufactured for use by the Health Sector II Project. These are:

- Conventional shallow-well
- Conventional deep-well
- Modified deep-well with PVC drop pipe and plastic foot valve

Table 1

HEALTH SECTOR II
Drilling Activity

	1980	1981	1982	1983	Total
Water Wells	138	268	545	316	1,267
Dry Wells	56 (29%)	118 (31%)	153 (22%)	99 (24%)	426 (25%)
Total Drilled	194	386	698	415	1,693
					(GOAL = 2,600)

Manufacturing

In 1983, production was halted after only 1,400 of the required 2,600 hand pumps had been manufactured. The reason was that quality of the hand pumps has been poor, and a substantial number of spare parts components have proved non-interchangeable. Manufacturing defects have ranged from poor casting of components to inaccurate dimensions.

Installation

As of December 1983, 1,083 hand pumps had been installed. (See Appendix A for a detailed listing.) As reported in WASH Field Report No. 98, methods practiced by the project's hand pump installation crews were not adequate, especially with the modified hand pump. Only one of the two contracted crews is still working. SESPAS plans to eliminate this crew also as health educators take over responsibilities for community pump installation.

Maintenance and Repair

Until October 1983, all hand pump maintenance and repair was also performed by crews working under a contract. However, health educators trained in hand pump maintenance and repair are beginning to assume these responsibilities with the help of community workers. Communities are now acquiring the basic tools necessary to repair their own hand pumps, and several communities should soon be more capable of handling maintenance and repair.

SESPAS records on hand pump installation and repair activity are summarized in Table 2. This data shows the severe maintenance problem that has been documented in WASH Field Report No. 98.

Spring-Capped, Gravity-Fed Water Systems

Although ordinarily more expensive to construct than drilled wells with hand pumps, water systems that are spring-capped and gravity-fed provide

Table 2

Health Sector II

Hand Pump Installation and Repair

	1980	1981	1982	1983	Total
Hand Pumps Installed	20	325	407	331	1,083
Pump Repairs	NA	NA	312	648	960

NA = Not Available

better service to communities. For instance, gravity-fed water systems require less complex maintenance and fewer repairs, reducing strain on community resources. To date, ten gravity-fed potable water systems have been constructed where springs have been found accessible, and seven sites are under study to determine feasibility of construction.

Water Storage

Local manufacturers produce water transportation and storage containers for sanitary collection and storage of potable water. Two types of plastic water containers are being fabricated, both designed to reduce contamination--a twenty-gallon container for home storage and a five-gallon container for water transport. One of each of the containers, which are distributed free of charge, is allocated per family in those communities equipped with hand pump or gravity-fed water systems.

As of 1982, approximately 15,000 twenty-gallon containers had been manufactured and thus far no problems with their quality have been reported. As of December 1983, health educators had delivered to rural communities only 4,942 twenty-gallon containers. Five-gallon containers are still being manufactured, but had not yet been received for distribution.

Excreta Disposal Systems

Latrines used by the project for excreta disposal are simple pit privies comprised of a reinforced concrete slab and riser.

Manufacturing

The Health Sector II Project Paper stipulated the manufacture of 14,300 latrine slabs and risers. This number, however, has been increased to 26,000 as a result of reprogramming conducted and approved in October 1983. The number of latrine systems manufactured to date is 14,686. This activity was contracted to private firms which have completed their original contracts. As a result of the training in latrine construction, health educators are now capable of manufacturing latrines with the help of the communities. At this point, SESPAS has not decided whether to continue with the private contractors or to have health educators and community members manufacture the latrines.

Installation, Maintenance, and Repair

Installation of the latrine slabs and risers also had been contracted out. Since April 1983, however, health educators trained in latrine installation have been installing the latrine components, including sheds over the latrines, with community workers. In addition to manufacture and installation, health educators are actively training communities in proper latrine maintenance and repair. As of December 1983, approximately 8,000 latrines had been completed, 3,000 of them since April 1983.

Health Education

Health educators work directly with the communities in their areas, promoting project activities and providing a wide range of health education to community members. In any technology transfer, recipients must understand and recognize the direct benefits of the technology offered. Promotion and health education activities are thus vital to the success of the Health Sector II program in improving the status of rural communities.

Prior Training

During April 1983, under the WASH Project, and October 1983, under IQC PDC-1406-I-00-1006 Work Order No. 2, Georgia Tech conducted five workshops for health educators, including one on promotion and health education. During latrine construction workshops, several lectures on promotion and health education were included. These lectures provided guidance to the health educators in discussing health aspects relative to excreta disposal and potable water use.

Training Materials Development

The following training manuals were being used:

- Hand Pump Installation, Maintenance and Repair Manual for Health Educators
- Hand Pump Installation, Maintenance and Repair Manual for Community Members
- Latrine Construction, Installation and Maintenance Manual for Health Educators

Health Sector II was also in the process of adapting a promotion and health education "field flipchart" to be used by the health educators for health education and promotion. The flipchart was successfully used in Honduras by the USAID PRASAR Project (a rural water supply and sanitation project). It contains Health Sector II goals and objectives, plus information on health problems related to poor sanitation practices and their solutions. At the end of April 1984 twenty-four health educators had been trained in the use of this flipchart.

3. PROTOTYPE DEVELOPMENT AND FIELD TESTING

Steel Hand Pump

Two chronic problems (see Figure 4) have been encountered with the cast iron AID pump design. Variations in manufacturing capabilities make castings and hardened pins and bushings of consistently high quality difficult to obtain in many areas. Preventive maintenance, especially lubrication of the pump after installation, has frequently been poor. A pump that is more easily manufactured and requires less maintenance may solve these problems.

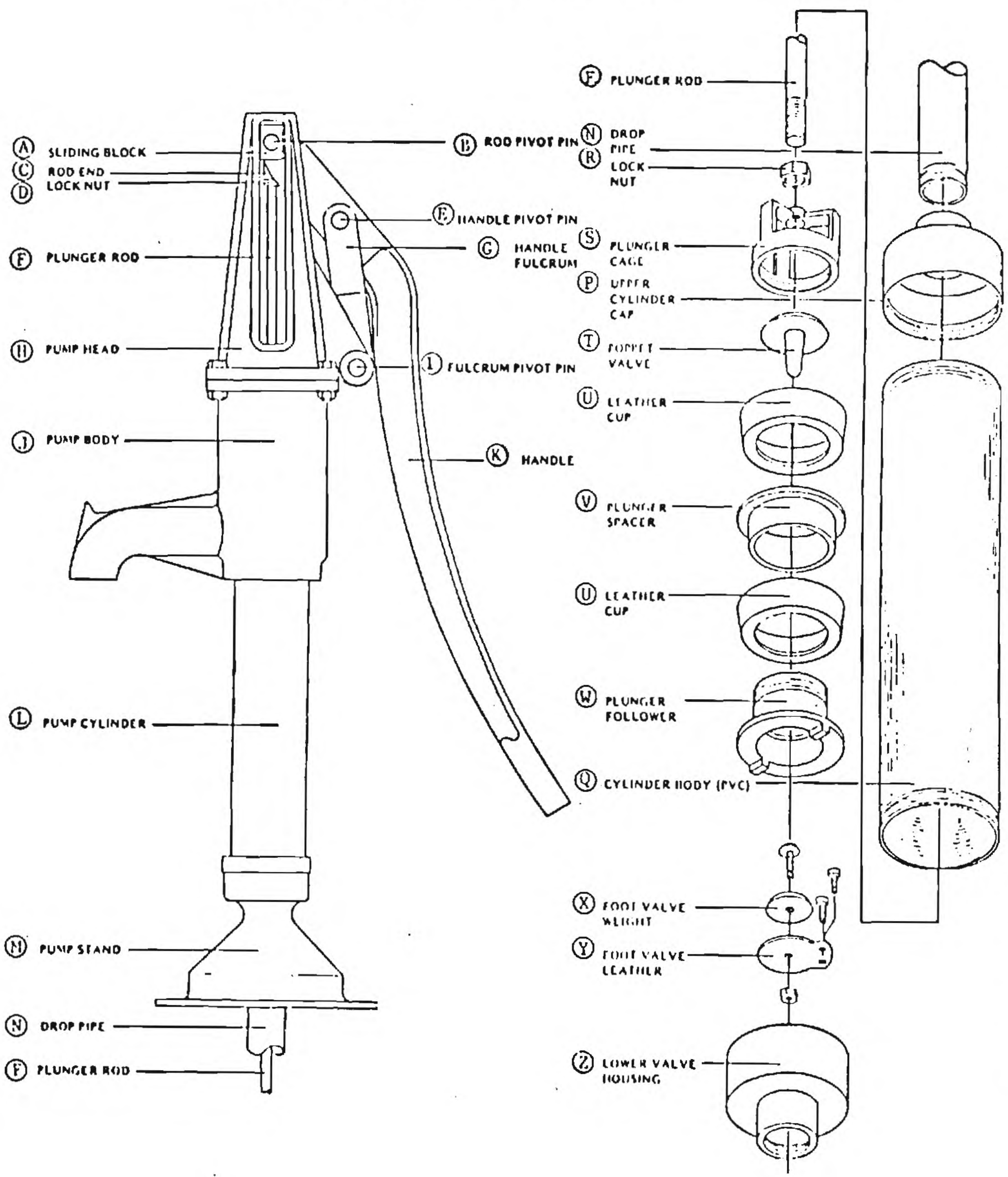
In the summer of 1983, using internal research funds, Georgia Tech staff investigated design concepts for an all-steel pump that did not require foundry capabilities and that minimized moving parts and used sealed ball bearings to reduce the incidence of pump failure caused by lack of lubrication. In addition, they developed designs of underground pump components that allow piston withdrawal through the drop pipe and changing of leather cups without having to remove the pump base or drop pipe.

Design criteria for the pump system were:

1. Costing between $100 and $150 (in equivalent foreign currency).
2. Made of raw materials readily available in developing countries.
3. Requiring only machine tools found in low technology machine shops (lathe, drill press, power hack saw, flame cutting torch, and electric welding machine).
4. Capable of pumping at a 200-foot static water level when operated by women and children.
5. Requiring minimal routine maintenance.
6. Capable of service and durability comparable to other hand pumps currently being used in less developed countries.
7. Capable of performing satisfactorily despite the manufacturing variances that regularly occur in developing countries.

Figure 4

AID HAND PUMP PROBLEM AREAS



PART	COMMON PROBLEMS
A	
B	Pins and bushings not properly hardened
C	
D	
E	Pins and bushings not properly hardened
F	
G	Breakage in fulcrum clevis
H	
I	Pins and bushings not properly hardened
J	Poor threading in pump body
K	Breakage in handle clevis
L	Poor threading on pump cylinder
M	Poor threading on pump stand
N	
P	Poor threading on cylinder cap
Q	
R	
S	Breakage in plunger cage
T	Poor sealing surface on poppet valve
U	
V	
W	
X	
Y	Foot valve leakage and breakage
Z	Poor threading on valve housing

Georgia Tech narrowed the overall concept to a pump fabricated from steel pipe and plate. It utilizes a handle with a circular segment connected to the plunger (piston) rod by motorcycle chain (similar to the India Mark II pump), and a single axle supported by two sealed ball bearings.

The theoretical output of this pump was calculated using a piston area of 3.142 square inches and a maximum piston stroke of 9.2 inches (determined from a 75° maximum angular displacement of the handle and a radius of 7 inches from the handle pivot to the pump rod axis). This would result in a theoretical output of 0.12 gallons of water per full stroke.

Engineering sketches were made for all of the components and a prototype pump was fabricated by personnel of the machine shop of the Engineering Experiment Station, who were instructed to use only the machine tools and equipment listed in the design criteria. After the prototype pump was completed, it was installed in the Georgia Tech pump testing laboratory and was operated for more than one million cycles with no major problems.

Based on these preliminary tests, design changes were made before constructing four additional prototypes for field testing in the Dominican Republic. Major design changes included:

1. Increasing the height of the pump body from 19 inches to 28 inches.
2. Eliminating a threaded connection at the top of the pump body.
3. Increasing the size of bearing support plates and enclosing their top, top half of end, and bottom to protect the chain and bearings.

Other minor changes were made in order to utilize materials locally available in developing countries.

Anticipated Field Problems

Even though the steel hand pump had undergone extensive testing (over one million cycles) in the pump testing facilities at Georgia Tech, experience on other hand pump programs indicated that there could be problems encountered under actual field conditions. The major anticipated field problems were:

1. Inability to withdraw the piston up through the drop pipe.
2. Women and children unable to exert enough force on the handle to pump water.
3. Premature bearing failure (under 3000 use hours).
4. Excessive chain slack during the handle up-stroke caused by the lack of constant tension applied to the chain.
5. Insufficient flow rate at 40 strokes per minute.
6. Insufficient strength of screws used to connect the chain to the handle and to the rod end.

Pump Test Site Selection Criteria

Effective field test sites for the steel hand pumps in the Dominican Republic provide the same range of conditions found throughout the country. At the same time, because of the transportation difficulties in installing these test pumps and later monitoring them, it was desirable that the sites be near Santo Domingo where both SESPAS and USAID/Dominican Republic are headquartered. With these needs in mind the following general test site selection criteria were established (see Figure 5 for the general area where actual test sites were selected):

1. Site to be no more than one hour's drive from Santo Domingo.
2. Static water level to range from a maximum of 200 feet to a minimum of 10 feet.
3. Each site to serve at least 5 families or 40 persons.
4. Sites to be easily accessible from "all-weather" roads.
5. Sites to be in Health Sector II Project districts.

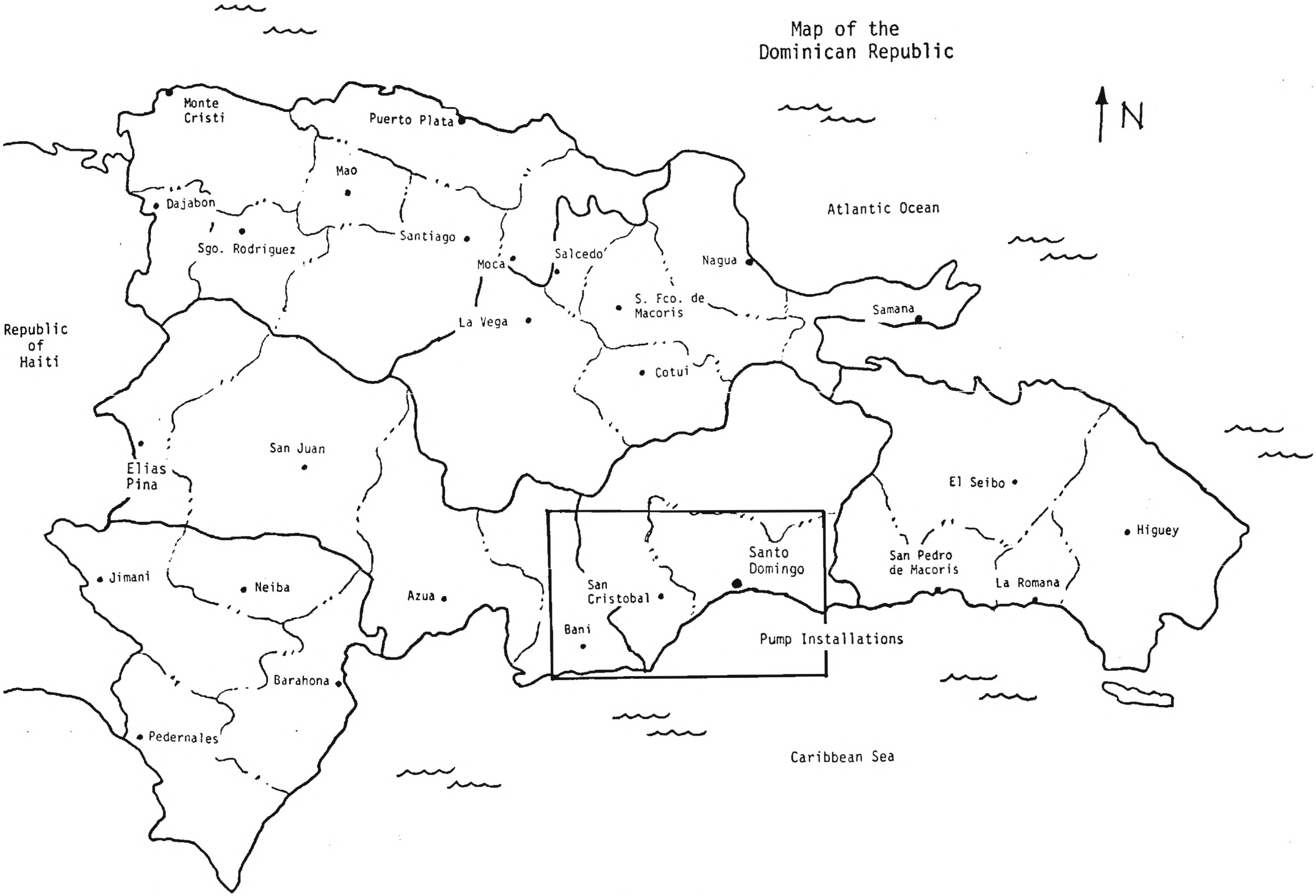


Figure 5
HAND PUMP TEST SITE AREA

Field Testing of Georgia Tech Manufactured Steel Pumps

Four prototype pumps made at Georgia Tech were shipped to the Dominican Republic in November 1983 for installation and field testing. Prior to installation, Georgia Tech engineers explained operation and installation techniques to representatives of USAID/Dominican Republic and to the Dominican Republic Secretariat of Health. The representatives jointly selected the test sites for the four prototype pumps (see Figure 6). Table 3 summarizes installation data including problems encountered.

All four of the steel hand pumps have received a high level of community acceptance. A general comment has been that the new pump is much easier to operate than the cast iron pumps. In all four installations, the pumps could be operated by women and children, and only the deep Haina well required a longer pump handle to provide more mechanical advantage.

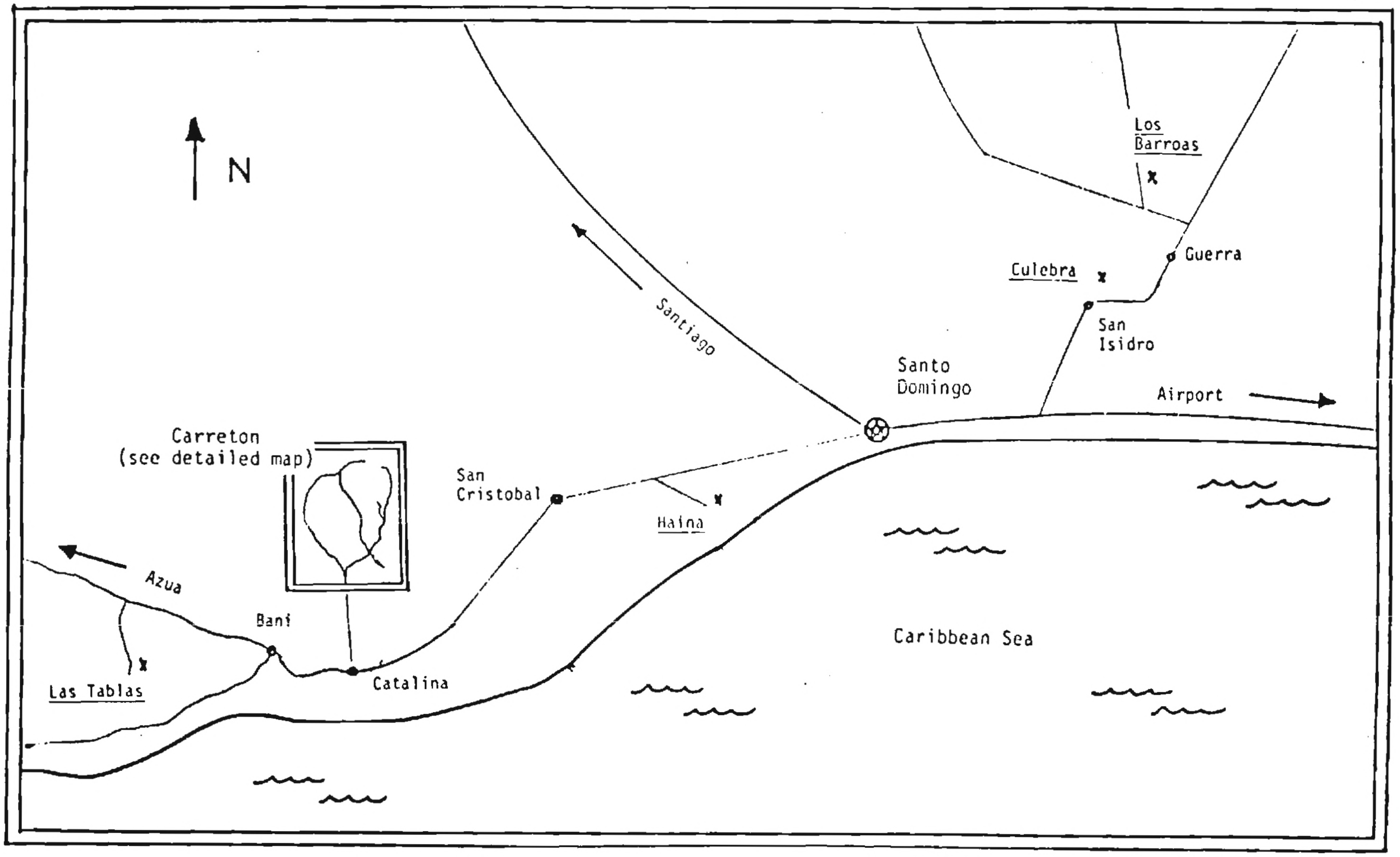
Each installation is described in further detail below.

Pump No. 1 - The first pump was installed on December 9, 1983, in a 6-inch tube well located approximately 10 miles west of Santo Domingo in the community of Haina. An AID-design cast iron hand pump with PVC drop pipe had previously been used, but had never operated longer than one week at a time without breaking down. This well was one of the deepest wells utilizing a hand pump in the Dominican Republic. Total well depth was 200 feet, with a static water level of 160 feet. The steel hand pump was installed with 180 feet of 2-inch galvanized steel drop pipe.

Upon testing, Georgia Tech engineers found that women and children could not operate the pump. The mechanical advantage on the pump handle, as originally designed, was 5.5:1. With 180 feet of 1/2-inch plunger rod, a 2-inch diameter piston and a static water level of 160 feet, a downward force of about 350 pounds was being exerted at the rod end of the pump handle. With only a 5.5:1 mechanical advantage, a force of around 64 pounds was required on the operating end of the handle. Increasing the

Figure 6

TEST SITE AREA FOR HAND PUMPS MANUFACTURED AT GEORGIA TECH



Pump Locations	Date Installed
Haina	12-9-1983
Las Tablas	12-10-1983
Culebra	12-12-1983
Los Barroas	12-13-1983

TABLE 3

INSTALLATION DATA SUMMARY FOR STEEL PUMPS MANUFACTURED AT GEORGIA TECH

PUMP NO.	WELL LOCATION	STATIC WATER LEVEL	TOTAL DEPTH	PIPE & ROD INSTALLED	MANUFACTURER	DATE OF INSTALLATION	FLOW RATE (GPM AT 40 STROKES/MIN)	REMARKS
1	Haina	160	200	180'	Ga. Tech	12/9/83	>2	Added 40 inches to handle to enable children to use pump. Allen screw used to connect chain to handle broke; replaced with solid steel pin 1/10/84. New handle and bearings installed on 2/13/84.
2	Las Tablas	72	86	80	Ga. Tech	12/10/83	>3	Poor well. Re-charge rate of well is less than out-put of pump.
3	La Culebra	73	96	80	Ga. Tech	12/12/83	>3	Chain pin broke; replaced with solid steel pin on 1/13/84.
4	Los Barroas	65	83	70	Ga. Tech	12/13/83	>3	Faulty cylinder; replaced on 1/13/84.

effective length of the handle by 40 inches gave a mechanical advantage of 12:1, decreasing the required downward force on the operating end of the handle to about 29 pounds. This change enabled even relatively small children to use the pump.

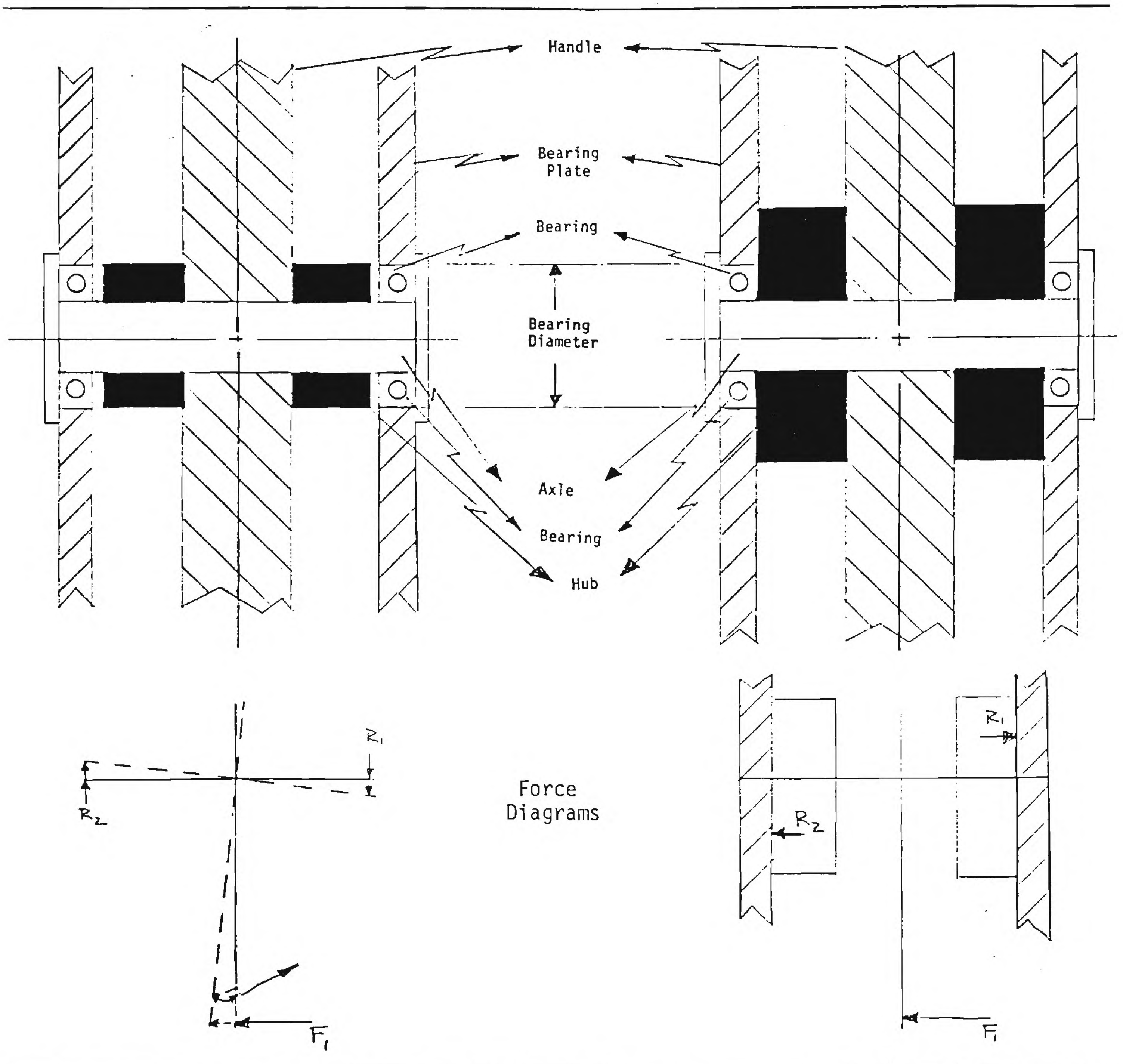
Initial flow rate of this pump was approximately 2.5 gallons per minute with 40 relatively short strokes per minute. About one hour after the initial installation, the pump became inoperable due to plunger rod separation. The pump cap was removed, and after 140 feet of plunger rod was pulled up, it was discovered that the separation was caused by the failure to tighten a rod coupling properly. Fourteen 10-foot sections of drop pipe were pulled up until the end of the remaining 40 feet of plunger rod was exposed. The remaining plunger rod and piston was pulled up through the drop pipe with no problem. The 10-foot sections of drop pipe were reinstalled along with the pump body. New leather cups were put on the piston, and the piston and plunger rod reinstalled. The pump cap and handle were then assembled to the pump body and a flow rate of 2.5 gallons per minute was reestablished. Even though the failure to take proper precautions in tightening a rod coupling caused much extra work, it provided the opportunity to verify that the system of withdrawing the piston up through the 2-inch drop pipe was not only possible but extremely practical.

During a check of the test pump on January 9, 1984, the pump again was inoperable due to breakage of a screw used to hold the chain to the handle. This screw was replaced on January 10 by a solid steel pin manufactured at a local machine shop. The screw used to connect the chain to the plunger rod was also replaced by a steel pin to prevent future breakage.

This pump performed flawlessly until the week of February 6, when the ball bearings supporting the handle axle failed. This failure was anticipated because of a design error in the hub diameter on the handle noticed during installation. (See Figure 7.) The outside diameter of the ball bearings used in the four prototypes was 1.125 inches, so the hub diameter should have been 1.750 inches. The "face-to-face" dimension of the hubs should

Figure 7

Section View of Handle Bearing Area Illustrating Importance of Hub Diameter



Original Design

Note that hubs and bearings are same diameter and that handle side play is possible permitting axle to exert non-radial force on bearings.

Improved Design

Note that hubs have much larger diameter than bearings and that there is very little clearance between hubs and bearing plates minimizing possible handle side play.

also have been less than 0.030 inch smaller than the inside dimension of the bearing plates. All this was necessary to prevent any non-radial (side thrust) loading on the bearing. With the hub diameter greater than the bearing exterior diameter and lateral movement of the handle between the bearing plates minimized, all of the bearing loading would be radial. The pump designs specified bearings that were rated for 900 pounds radial loading at 33 R.P.M. The theoretical total loading on the axle with 220 feet of drop pipe and a static water level of 200 feet would be less than 500 pounds. Each bearing would carry 250 pounds radial or about 27% of rated capacity. Reviewing the original design calculations reinforced the conclusion that bearing failure was caused entirely by side thrust and not by excessive radial load.

On the four pumps produced at Georgia Tech, the hub diameter was the same as the bearing outside diameter, and the face-to-face dimension of the hubs was over 0.125 inch smaller than the inside dimension of the bearing plates. When these discrepancies were discovered during installation, an attempt was made to overcome the problem by adding large washers. This would probably have worked had not the handle been lengthened considerably. The extra length of the handle intensified the hub problems, bringing about premature bearing failure. A new handle correcting the dimensional problems was fabricated in Santo Domingo for this pump. The new handle and bearings were installed on this pump during the week of February 13.

An interesting sidelight is that, even though the bearings failed, the pump continued operating. The balls in the bearings dropped out and the axle shaft was worn badly, but the only effect reported by community members was that more effort was required to operate the pump.

In late March 1984, this pump was inspected during a bi-monthly visit by SESPAS and found to be inoperable. SESPAS technicians, upon repairing this pump in March, found that the problem was caused by one joint of the plunger rod coming unscrewed. (This problem is common to all pump systems using threaded joints.)

Pump No. 2 - The second steel pump was installed on December 10 in a 6-inch tube well located approximately 40 miles west of Santo Domingo in the community of Las Tablas. An AID cast iron hand pump with 1.25-inch galvanized steel drop pipe was removed in order to test the steel pump. Total depth of this well was 86 feet, with a static water level of 72 feet. A steel hand pump with 80 feet of 2-inch galvanized steel drop pipe was installed without incident. Upon pumping, an initial flow rate of approximately 3.5 gallons per minute was obtained using 40 moderate strokes per minute. After only a few minutes of pumping, however, the water became extremely muddy. While trying to clear up the muddy flow of water, pump output ceased due to lack of water in the well. After questioning the people in the community, Georgia Tech engineers determined that this well had always had a problem with a slow rate of recharge. Representatives of Georgia Tech, USAID, and the Secretariat of Health decided at that time to leave the pump installed and see if the recharge rate improved with increased usage of the well.

In late January, the well had improved its recharge rate considerably. People in the community could continuously remove water from this well at the rate of 3.5 gallons per minute for about 15 minutes before experiencing water depletion. Witn a drop pipe total depth of 82 feet (including a 2-foot long cylinder) and a static water level of 72 feet, about 15 gallons of water were available above the foot valve. With a removal rate of 3.5 gallons per minute and zero recharge rate, it would require only about four minutes to deplete the available water. From this data Georgia Tech engineers estimated that the recharge rate was between 2.0 and 2.5 gallons per minute. People in the community were very satisfied with the way the pump operated and did not seem to mind the inconvenience of the minimal recharge rate, so the pump was left installed.

On January 11, the screws used to connect the chain to the handle and to the plunger rod were replaced with steel pins to prevent future breakage. As of late March 1984, this pump was functioning without any problems other than the recharge rate.

Pump No. 3 - The third pump was installed on December 12 in a 6-inch tube well located approximately 20 miles east of Santo Domingo in the community of La Culebra. A very old Dempster pump with galvanized steel drop pipe was removed in order to test the steel pump. Total depth of the well was 96 feet, with a static water level of 73 feet. A steel hand pump with 80 feet of 2-inch galvanized steel drop pipe was installed without incident. Upon pumping, an initial flow rate of approximately 4 gallons per minute was obtained using 40 moderate strokes per minute. On January 13, the screws used to connect the chain to the handle and to the plunger rod were replaced by solid steel pins as used at the Haina and Las Tablas sites. The screws here had broken but a nail had been used temporarily and the pump was still operating.

In late March, this pump was inspected, along with all other test pumps, during a routine bi-monthly visit by SESPAS and found to be operating satisfactorily.

Pump No. 4 - The fourth pump was installed on December 13 in a 6-inch tube well located approximately 20 miles east of Santo Domingo, in the community of Los Barroas. An old Dempster pump with galvanized steel drop pipe was removed in order to test the steel pump. Total depth of this well was 83 feet, with a static water level of 65 feet. A steel hand pump with 70 feet of 2-inch galvanized steel drop pipe was installed without incident in less than 2.5 hours. Upon pumping, an initial flow rate of approximately 4 gallons per minute was obtained using 40 moderate strokes per minute.

On January 12, the screws used to connect the chain to the handle and to the plunger rod were replaced with steel pins to prevent future breakage.

While reassembling the pump, the piston and plunger rod slipped and the impact against the bottom of the cylinder caused the cylinder to break apart several inches from the bottom. A vise had been used to hold the cylinder during hand threading at Georgia Tech, and this operation may have led to an unnoticeable fracture of the PVC. On January 13, a new cylinder was added to the system and the pump re-installed.

As of late March 1984 this pump was inspected and found to be operating satisfactorily.

Field Testing of Locally Manufactured Steel Pumps

In December 1983, Georgia Tech engineers ordered 12 steel hand pumps from four manufacturers in the Dominican Republic. (See Chapter 4.) Pumps from three of the manufacturers were delivered in January 1984. On January 23, the installation of steel pumps manufactured by Cedeno Industrial, Senra Tool & Die, and Marino Hernandez & Associates began in a group of small communities near Bani, approximately 35 miles west of Santo Domingo (see Figure 8). Representatives of Georgia Tech, USAID, and the Secretariat of Health selected the sites. All of the sites were easily accessible by automobile. Table 4 summarizes installation data including problems encountered for these pumps.

Pump No. 5 - On January 23, 1984, an AID cast iron pump was removed and a steel pump manufactured by Cedeno installed next to the house of the local health promotor, Eulogia Gonzales, in the community of Carreton. The well had a total depth of 59 feet, with a static water level of 20 feet. Total length of drop pipe installed was 50 feet. The pump was installed without major complications and gave a flow rate of approximately 4 gallons per minute at 40 strokes per minute. A minor problem encountered was the axle pin not fitting snugly in the handle bore. Using a centerpunch to reduce the diameter of the handle bore resolved this problem.

As of late March 1984 this pump was operating satisfactorily.

Pump No. 6 - A Cedeno steel pump was installed on January 24, near the house of Julio Antonio Melo. This 6-inch tube well had a total depth of 49 feet, with a static water level of 11.5 feet. The total amount of drop pipe installed was 40 feet. There were no complications during installation. The pump delivered a flow rate of approximately 4 gallons per minute at 40 strokes per minute. During a later inspection tour of the installed

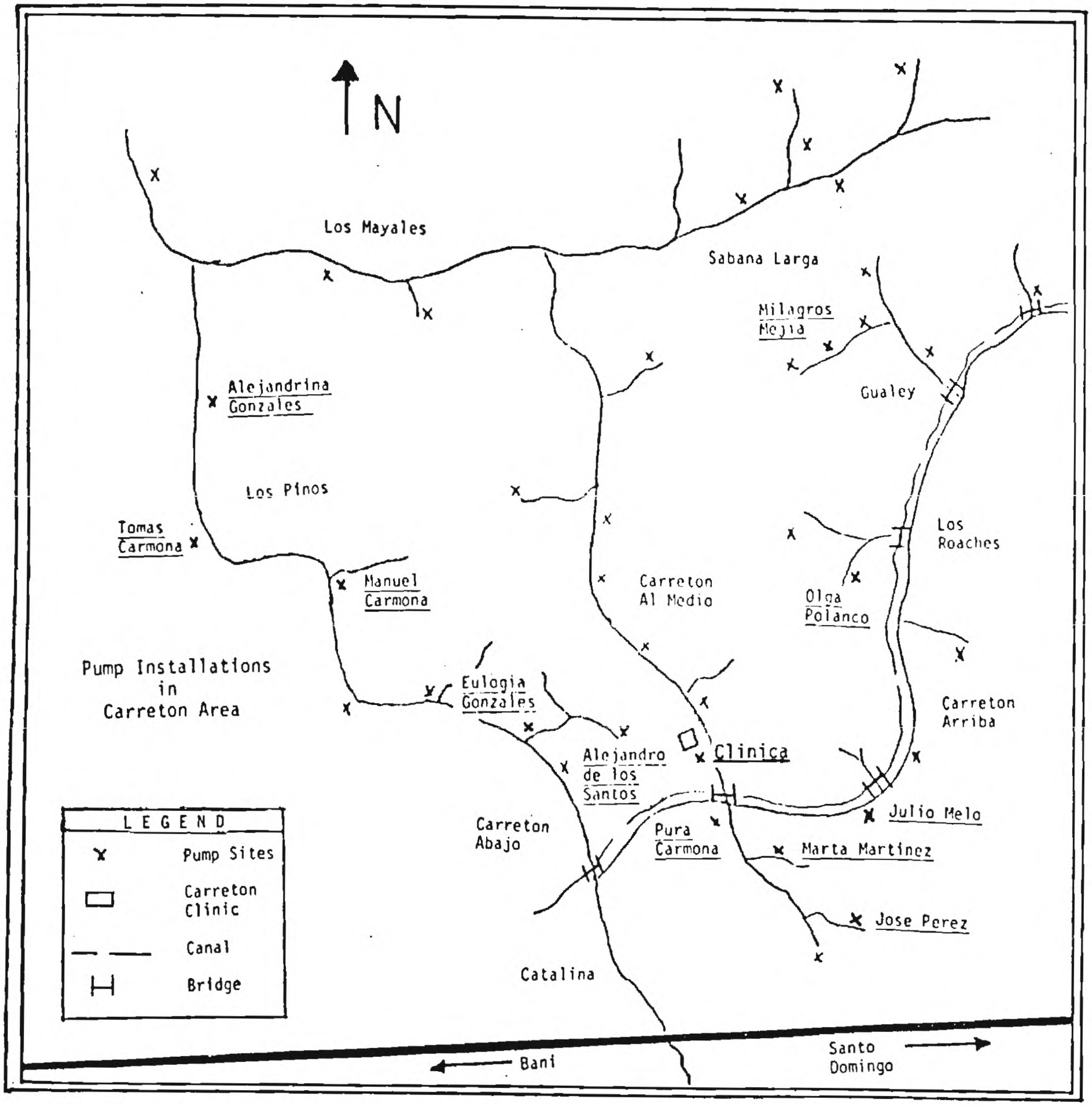


Figure 8

TEST SITE AREA FOR HAND PUMPS MANUFACTURED IN THE DOMINICAN REPUBLIC

Pump Locations	Date Installed
Euglogia Gonzales	1-23-1984
Julio Antonio Melo	1-24-1984
Carreton Clinic	1-24-1984
Manuel Carmona	1-25-1984
Tomas Carmona	1-25-1984
Milagros Mejia	1-28-1984
Olga Polanco	1-28-1984
Jose Perez	1-29-1984
Alejandrina Gonzales	1-29-1984
Alejandro de los Santos	1-30-1984
Marta Martinez*	1-30-1984
Pura Carmona*	1-31-1984

*Marta Martinez and Pura Carmona sites were installed with AID modified cast iron pumps with 2-inch steel drop pipe and removable piston system. All other sites were installec with steel pumps manufactured in the Dominicar Republic.

Table 4

INSTALLATION DATA SUMMARY FOR STEEL PUMP MANUFACTURED IN THE DOMINICAN REPUBLIC

PUMP NO.	WELL LOCATION	STATIC WATER LEVEL	TOTAL DEPTH	PIPE & ROD INSTALLED	MANUFACTURER	DATE OF INSTALLATION	FLOW RATE (GPM AT 40 STROKES/MIN)	REMARKS
5	Eulogia Gonzales	20	59	50	Cedeno	1/23/84	>3	Handle hole for axle slightly oversize. The effective hole diameter was reduced by center punching which solved the problem.
6	Julio Antonio Melo	11 1/2	49	40	Cedeno	1/24/84	>3	No problems.
7	Clinica de Carreton	12 1/2	30 1/2	20	Cedeno	1/24/84	>3	Chain snap observed. This was due to lack of sufficient downward force applied to the rod end caused by the extreme shallowness of the well. A 7.5 pound weight was added to the rod in the pump body to solve the problem.
8	Manuel Carmona	14 1/2	60	50	Senra	1/25/84	>3	The manufacturer had not welded the hubs to the handle causing alignment difficulties during installation.

Table 4 (continued)

INSTALLATION DATA SUMMARY FOR STEEL PUMP MANUFACTURED IN THE DOMINICAN REPUBLIC

PUMP NO.	WELL LOCATION	STATIC WATER LEVEL	TOTAL DEPTH	PIPE & ROD INSTALLED	MANUFACTURER	DATE OF INSTALLATION	FLOW RATE (GPM AT 40 STROKES/MIN)	REMARKS
9	Tomas Carmona	29 1/2	61	50	Senra	1/25/84	>3	Same problems encountered as Pump No. 8.
10	Milagros Mejia	51	72	60	Cedeno	1/28/84	>3	Problems were encountered because of a misalignment problem in the handle holes to which the chain is connected. Problem was solved by redrilling.
11	Olga Polanco	7	47	40	Cedeno	1/28/84	>3	Same problems encountered as Pump No. 10. However, handle was broken while trying to correct the problem. The broken handle was substituted by the handle from another pump.
12	Jose Perez	12	24 1/2	15	Cedeno	1/29/84	>3	Chain snap observed due to same problems noted in Pump No. 7. Two 7.5 pounds weights were added which solved the problem.

Table 4 (continued)

INSTALLATION DATA SUMMARY FOR STEEL PUMP MANUFACTURED IN THE DOMINICAN REPUBLIC

PUMP NO.	WELL LOCATION	STATIC WATER LEVEL	TOTAL DEPTH	PIPE & ROD INSTALLED	MANUFACTURER	DATE OF INSTALLATION	FLOW RATE (GPM AT 40 STROKES/MIN)	REMARKS
13	Alejandrina Gonzales	39	62	55	Marino	1/29/84	>3	Slight chain snap was observed which soon disappeared.
14	Alejandro de Los Santos	28	60	50	Cedeno	1/30/84	>3	Slight alignment problem with chain pin hole in handle.

pumps, flow rate was found to have decreased to approximately 3.5 gallons per minute.

As of late March 1984 this pump was operating satisfactorily.

Pump No. 7 - On January 24, a Cedeno steel pump was installed in front of the Carreton clinic, replacing an AID shallow-well pump. The well had a total depth of 30.5 feet with a static water level of 12.5 feet. The total amount of drop pipe installed was 20 feet. A non-standard axle pin required that a bearing be removed before mounting. This removal was not consistent with the design intent of the drawings, so a new handle was ordered from Cedeno. As of January 31, the flow rate was approximately 3.5 gallons per minute at 40 strokes per minute. Due to the shallowness of the well, there was a slight chain snap after installation. The rod and piston were pulled and new cups sanded down to fit loosely in the cylinder. There was still a slight chain snap. On January 25, a 7.5 pound weight was added to the rod in the pump body, which eliminated the chain snap. A hose was attached to the pump in order to fill a storage tank at the clinic. The pressure caused water to leak through the gland plate-body joint, which was later corrected by installing a gasket.

As of late March 1984 this pump was operating satisfactorily.

Pump No. 8 - A Senra steel pump was installed on January 25, near the house of Manuel Carmona. Total depth of the well was 60 feet with a static water level of 14.5 feet. The total amount of drop pipe installed was 50 feet. The flow rate was approximately 3.5 gallons per minute when last recorded on January 31. Senra had included handle hubs as separate pump components rather than welding them to the pump handles as specified, and inserting the axle pin into the handle was somewhat difficult. Otherwise, the pump was installed without complications.

As of late March 1984 this pump was operating satisfactorily.

Pump No. 9 - A Senra steel pump was installed on January 25, near the house of Tomas Carmona. Total well depth was 61 feet with a static water level of 29.5 feet. Total drop pipe installed was 50 feet. The pump was installed without complications except for the same hub problem noted for Pump 8 above. A flow rate of approximately 3 gallons per minute was recorded.

As of late March 1984 this pump was operating satisfactorily.

Pump No. 10 - A Cedeno steel pump was installed on January 28, near the house of Milagros Mejia. The well had a total depth of 72 feet, with a static water level of 51 feet. Total amount of drop pipe installed was 60 feet. The installation was hampered by a poorly manufactured chain-handle pin connection. This was an unauthorized design change that Cedeno made to ease manufacture of the part. Since the fit of the steel pin where the chain is connected to the handle is snug (to eliminate lateral movement) the holes must be aligned so that the pin can pass through the handle. In this pump, the holes were not aligned. With a drill and small file, the problem was corrected. The pump gave a flow of about 4 gallons per minute.

As of late March 1984 this pump was operating satisfactorily.

Pump No. 11 - A Cedeno steel pump was installed on January 28, near the house of Olga Polanco. The well had a total depth of 47 feet with a static water level of 7 feet. Total drop pipe installed was 40 feet. The manufacturing defects previously mentioned in the chain-handle pin connection caused installation problems. In an attempt to correct chain alignment, a welded joint in the pump handle broke, requiring substitution of a handle from another pump. After installation, flow rate was about 4 gallons per minute. The drop pipe installed with the new pump was much closer to the well bottom than the old drop pipe causing the pumped water to be muddy until the following day.

As of late March 1984 this pump was operating satisfactorily.

Pump No. 12 - A Cedeno steel pump was installed January 29, near the house of Jose Perez. This site provided a very shallow well to test the steel pump. Total well depth was 24.5 feet, with a static water level of 12 feet. Total amount of drop pipe installed was 15 feet. Considerable chain snap was evident after installation. The rod and piston were pulled, new cups were sanded down, and two weights of 7.5 pounds added. After these changes were made, there was only a slight chain snap which disappeared within several days as the cups and gland packing loosened with use. Flow rate, as recorded on January 31, was 4 gallons per minute at 40 strokes per minute.

As of late March 1984 this pump was operating satisfactorily.

Pump No. 13 - The only available Marino Hernandez steel pump was installed near the house of Alejandrina Gonzales on January 29, 1984. Total depth of the well was 62 feet, with a static water level of 39 feet. Total drop pipe installed was 55 feet. Due to manufacturer's dimensional defects in the axle shaft and chain-handle pins, the handle was difficult to install. Some chain snap was evident immediately after installation, but disappeared in a few days. The flow rate recorded was 4 gallons per minute. This was the only locally-produced pump with sealed bearings (Nachi 6001 NSL) called for in the design. The Senra and Cedeno pumps had been manufactured improperly with shielded bearings (Nachi 6001 Z), which would have a higher probability of corrosion failure.

As of late March 1984 this pump was operating satisfactorily.

Pump No. 14 - A Cedeno steel pump was installed on January 30, near the house of Alejandro de los Santos. The original shielded bearings (Nachi 6001 Z) were replaced by Georgia Tech personnel with sealed bearings (Nachi 6001 NSL). The well had a depth of 60 feet, with a static water level of 28 feet. Total drop pipe installed was 50 feet. The pump was installed with minor complications of the chain connection pins caused by the same defects reported above in the handle of the Cedeno pump. A flow rate of 4 gallons per minute was recorded.

As of late March 1984 this pump was operating satisfactorily.

Field Testing of AID Modified Cast Iron Pumps with 2-Inch Steel Drop Pipe and Removable Piston System

In 1980, it had been decided to modify the standard design AID hand pump by changing from 1 1/4-inch steel drop pipe to 2-inch PVC drop pipe. (See Figure 9.) This necessitated redrilling and rethreading the pump base for a 2-inch steel pipe nipple and PVC adapter. This system using PVC drop pipe has not worked and has since been discontinued. To determine if the AID modified pump could be retrofitted by replacing its underground components with the Georgia Tech system, it was decided to use two test wells with this arrangement. Table 5 summarizes installation data including problems encountered for these two installations.

Pump No. 15 - An AID modified pump was installed near the house of Marta Martinez January 30, using the Georgia Tech underground system of 2-inch galvanized pipe with 2-inch Schedule 80 PVC cylinder. Well depth was 34.5 feet with a static water level of 11.5 feet. Total amount of drop pipe installed was 25 feet. The AID pump performed well with the new underground system. No installation problems were encountered. Recorded flow rate was 3 gallons per minute.

As of late March 1984 this pump was operating satisfactorily.

Pump No. 16 - An AID modified pump with the Georgia Tech underground system was installed near the house of Pura Carmona on January 31. The well had a depth of 46 feet, with a static water level of 8 feet. A total of 30 feet of drop pipe was installed. The pump was installed with no complications, with a flow rate of 3.5 gallons per minute recorded.

As of late March 1984 this pump was operating satisfactorily.

AID MODIFIED HAND PUMP
WITH PVC DROP PIPE

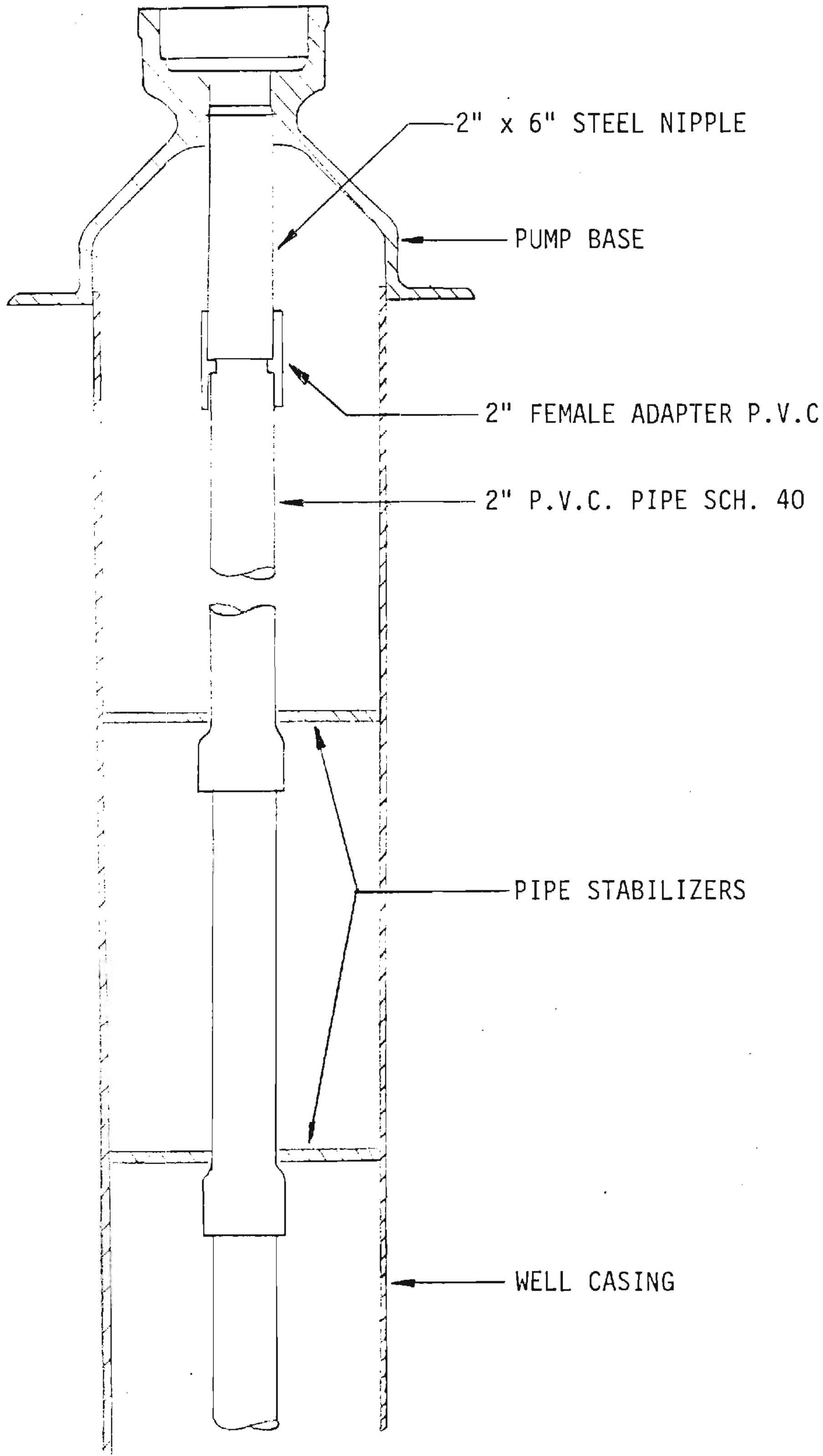


Figure 9

Table 5

INSTALLATION DATA SUMMARY FOR AID MODIFIED CAST IRON PUMPS

PUMP NO.	WELL LOCATION	STATIC WATER LEVEL	TOTAL DEPTH	PIPE & ROD INSTALLED	MANUFACTURER	DATE OF INSTALLATION	FLOW RATE (GPM AT 40 STROKES/MIN)	REMARKS
15	Marta Martinez	11 1/2	34 1/2	25	AID Modified	1/30/84	>3	No problems.
16	Pura Carmona	8	46	30	AID Modified	1/31/84	>3	No problems.

Conclusions and Recommendations

The Dominican Republic test sites have been ideal in exposing the steel hand pump to a wide variety of conditions that have allowed design, manufacturing, and installation adaptations to be made in an expeditious manner. They have also challenged the strength of the pump components, especially so at the Haina site where the well is over 200 feet deep.

Even though minor installation, design and manufacturing problems have occurred in the short period of the pump's development, the steel pumps have met the design criteria of pumping performance, materials availability and in-country manufacturability. It is anticipated that these pumps will also meet the design criteria of cost, maintainability and satisfactory performance despite manufacturing variances. For example, of the 14 sites where the steel pumps have been installed, 12 have had pumps that have been trouble free since installation. The other 2 pumps have experienced minor and anticipated problems with bearing failure (see Pump No. 1), chain connector breakage (see Pump No. 1 and Pump No. 3).

Two AID cast iron hand pumps were installed on the identical underground system (2" steel drop pipe with 2" Schedule 80 PVC cylinder and removable piston) used on the steel hand pumps. These two test sites have also been trouble free.

Although the prototype steel pumps have performed well, the test period has been short--four months for the 4 steel pumps manufactured at Georgia Tech's machine shop and two months for the 10 steel pumps manufactured in the Dominican Republic. Ideally, this initial test period for these prototype steel pumps should include a scheduled "tear down" at the end of three months of field operation. This "tear down" should involve removing the complete system (cylinder, drop pipe, drop rod and pump superstructure) from the well. All components would be disassembled and inspected thoroughly for wear, signs of premature failure, and vandalism. If at this time component modifications were deemed necessary in any one pump they would be made in all of the test pumps. This process would be repeated until all of the test pumps had been inspected and, if necessary, modified. Ideally, this process would be repeated until at least nine months of use had been experienced or until component modifications were no longer necessary.

The 14 steel pumps and the 2 AID cast iron pumps being tested in the field now need to be removed from the wells and all components closely inspected to complete the evaluation of their performance. From these inspections, conclusions regarding the durability of the steel design hand pump in the Dominican Republic can be drawn. The inspections will also show if further design modifications are necessary. (Current recommended design drawings reflecting minor modifications in the bearing assembly and the handle/chain linkage are shown in Appendix B.)

Technical assistance is also necessary in preparing bid documents for the future local manufacture of hand pumps (the AID cast iron design or the steel design), the selection of future manufacturers, and the actual manufacture of the hand pumps. This technical assistance, if administered properly and coupled with continued training in hand pump installation, maintenance and repair, should contribute to the successful completion of the Health Sector II Project.

Water-Seal Toilet

In many developing nations of the world, the standard of living is slowly rising. With improved communications and rising literacy, citizens of these countries are beginning to realize the enormous gap that exists between the quality of life in the developed nations and Third World countries. What is a commonplace item and taken for granted in a developed nation is a sought-after luxury in an underdeveloped country. One of these items is a toilet which can provide privacy, comfort, and sanitation. While there are many designs and schemes for sanitary latrines, the simple "pour-flush" water-seal latrine has several advantages. In addition to its low cost, the water-seal latrine prevents escaping odors from the waste pit and prevents flies and other insects from spreading disease.

Based on discussions with American Standard personnel and Ministries of Health in other Latin American countries, the most desirable material for the water-seal toilet seems to be glazed and fired ceramic. Columbia, for example, is currently exporting a glazed and fired ceramic water-seal toilet to other South and Central American countries at a cost of less than \$10. Unfortunately, the capital required to start a glazed and fired ceramic (sanitary ware) operation may be in excess of \$2 million and requires a large sales volume to break even. The large amounts of capital, process technology, and quality control procedures necessary to produce an acceptable product have, therefore, limited the number of companies established to produce sanitary ware.

To address these needs, Georgia Tech, through internal research funds, had investigated design concepts for a concrete water-seal toilet which could be more easily manufactured in-country. Primary design criteria were:

1. Cost of under \$10 (in equivalent foreign currency).
2. Capital requirements for manufacturing facilities less than \$10,000.
3. Weight less than 75 pounds.
4. Ability to resist breakage while being transported between factory and installation site.
5. Ability to flush with less than one gallon of water.
6. Aesthetically acceptable to potential users (similar to glaze).
7. "Sit" rather than "squat" type.

After investigating water-seal toilets currently being produced in Central and South America, several different design concepts were considered. One of the major problems encountered in trying to design an easily manufactured concrete toilet was in providing the internal "S" path for the fluid flow which would create the water seal. Experiments were conducted using a

3-inch PVC pipe, bevel cut and glued to form a "Z". Used inside a plaster-of-Paris mockup, the design provided an effective water seal. Flushing action of this configuration left much to be desired, however. Informal flushing tests using small sticks, leaves, and wadded paper indicated that one gallon of water or more was required to flush.

Georgia Tech also investigated several types of concrete designs. The optimum design should be easy to cast and have a relatively high strength in the thin sections. Various mixtures of concrete were prepared and formed into 10-inch square slabs, 1-inch thick. These slabs simulated the thinnest section of the toilet and could be visually inspected for smoothness and surface finish before being broken in a tensile testing machine during a comparative breakage test. From these test results, Georgia Tech engineers could determine which concrete mixtures would be appropriate for the toilet construction.

After consulting concrete experts on the Georgia Tech campus, Georgia Tech engineers decided to use a concrete mixture that would give a compressive strength of 6,000 psi with a type II cement to minimize shrinkage. Since workability is a prime requirement for pouring concrete into a mold, plasticizers were used in some mixtures to observe their effects. Chopped fiberglass was also used in some mixtures to increase the strength of the concrete.

After considering compressive strength, slump and workability, 16 different mixtures were made and formed into slabs. The mixtures with the plasticizers provided the highest slump and workability, but the least compressive strength, cracking in the comparative breakage test at 150 pounds. The mixtures that provided the combination of high strength with high slump contained air entrainment additives plus chopped fiberglass, cracking in the comparative breakage test at approximately 460 pounds. The surface finish of these two mixtures was also satisfactory--smooth and non-porous.

Georgia Tech also researched several coating systems for the concrete latrine. These systems included epoxies, polyamides, and polyurethanes.

However, further development of the concrete toilet has not been carried out under the project described herein because the USAID Mission feels that water-seal toilets are inappropriate for the Dominican Republic. (See discussion below.) During the development of the concrete latrine, Georgia Tech project personnel were investigating the availability of existing ceramic toilets for the Dominican Republic. American Standard, Inc., for example, has 17 companies, usually joint ventures, outside of the United States. Six of these companies are located in Latin American countries (Costa Rica, Dominican Republic, Guatemala, Nicaragua, Mexico, and Brazil). Companies in the first four countries are in the process of developing high quality water-seal toilets that can be priced at less than $10 (competitive with the Colombia toilet).

The company in the Dominican Republic, Sanitarios Dominicanos, S.A. (SADOSA), has produced six of these toilets which were given to SESPAS for installation in the Health Sector II project area. Users of the toilets have reported that the water-seal toilets are much nicer (no offensive odors) than pit latrines; however, they require between one and two gallons of water for flushing. The USAID Mission has also followed up on the performance of the toilets and reports that they have a tendency to become clogged with rocks and corn cobs used by villagers for cleaning purposes. For this reason, the USAID Mission prefers to stay with the pit latrine for the Health Sector II Project.

Conclusions and Recommendations

Even though water-seal latrines can provide privacy, comfort, and sanitation, they do require water to flush, usually between one-half and one gallon. In areas without gravity flow or mechanically powered water systems it is unlikely that people will walk to community hand pumps, spend several minutes and much energy pumping water, and carry it home to flush a latrine. Therefore, it has been concluded by USAID/DR that water-seal toilets are not appropriate for the Health Sector II Project.

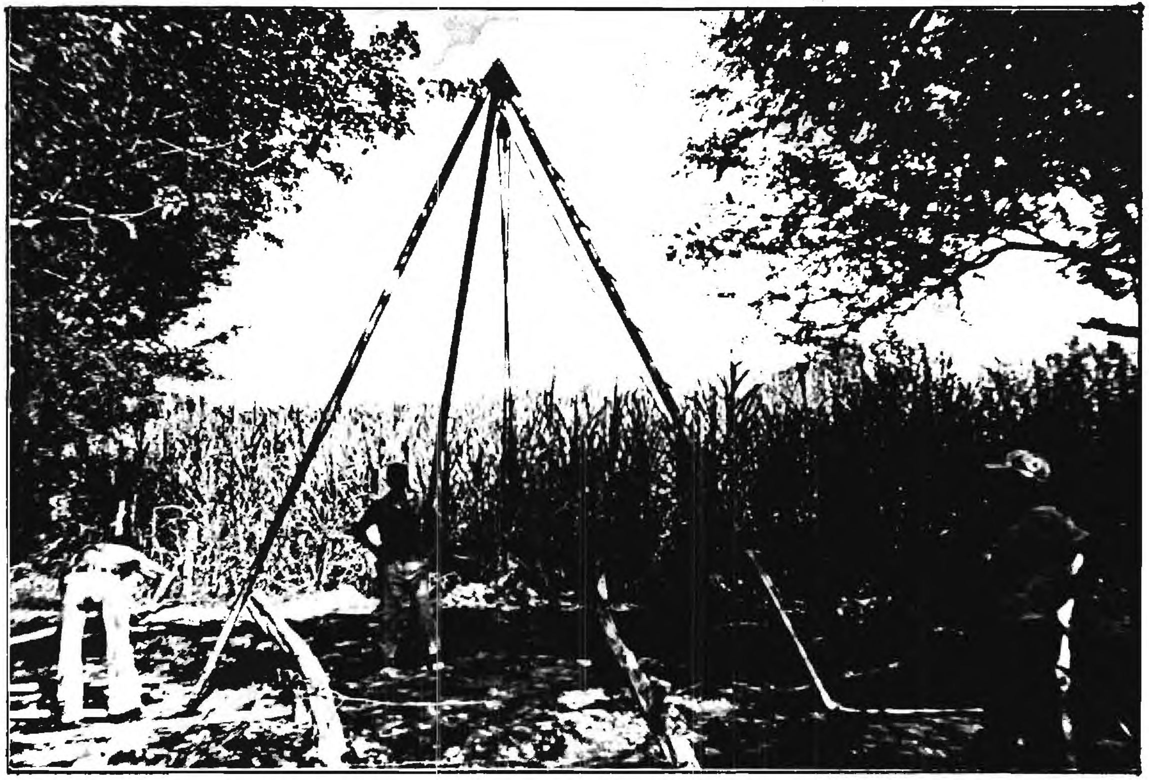
While the concrete water-seal toilet may not be appropriate for the Health Sector II Project, its development should be considered for use in other developing countries where convenient water sources are available.

Tripod

The extra weight associated with the large diameter (2-inch) drop pipe required on the steel pump system necessitates an improved system for pump installation and removal. The basic component of this system was a support onto which a hoist could be suspended for lowering or raising the drop pipe. Design criteria for this device were that it be:

1. Portable (able to be transported in a short-bed pickup truck).
2. Capable of supporting 2000 pounds from an apex approximately 16 feet above ground level.
3. Adjustable at each individual leg.
4. Easy to erect.
5. Safe to erect and operate.
6. Reasonably priced at less than $500 (U.S.).

Many unipod, bipod, and tripod concepts were considered, including the gin pole and guyed ladder frame. The concept finally used, however, was that of the traditional tripod. (See Figures 10 and 11.) The tripod consists of three 10-foot legs of 2-inch Schedule 40 steel pipe which telescope into three 10-foot legs of 2 1/2-inch Schedule 40 steel pipe. The three upper legs are bolted together by means of an angled plate system. Individual legs are adjustable using a series of 5/8-inch holes spaced every 6 inches on the inner legs, with two 5/8-inch holes drilled 4 inches from the bottom of each outer leg. By inserting a 4-inch long 5/8-inch bolt through the hole in the outer leg and passing through the hole in the inner leg, the total length of the two legs can be adjusted in increments of 6 inches. The apex of the tripod on level ground ranges from 8 1/2 feet (fully retracted) to 15 1/2 feet (fully extended).



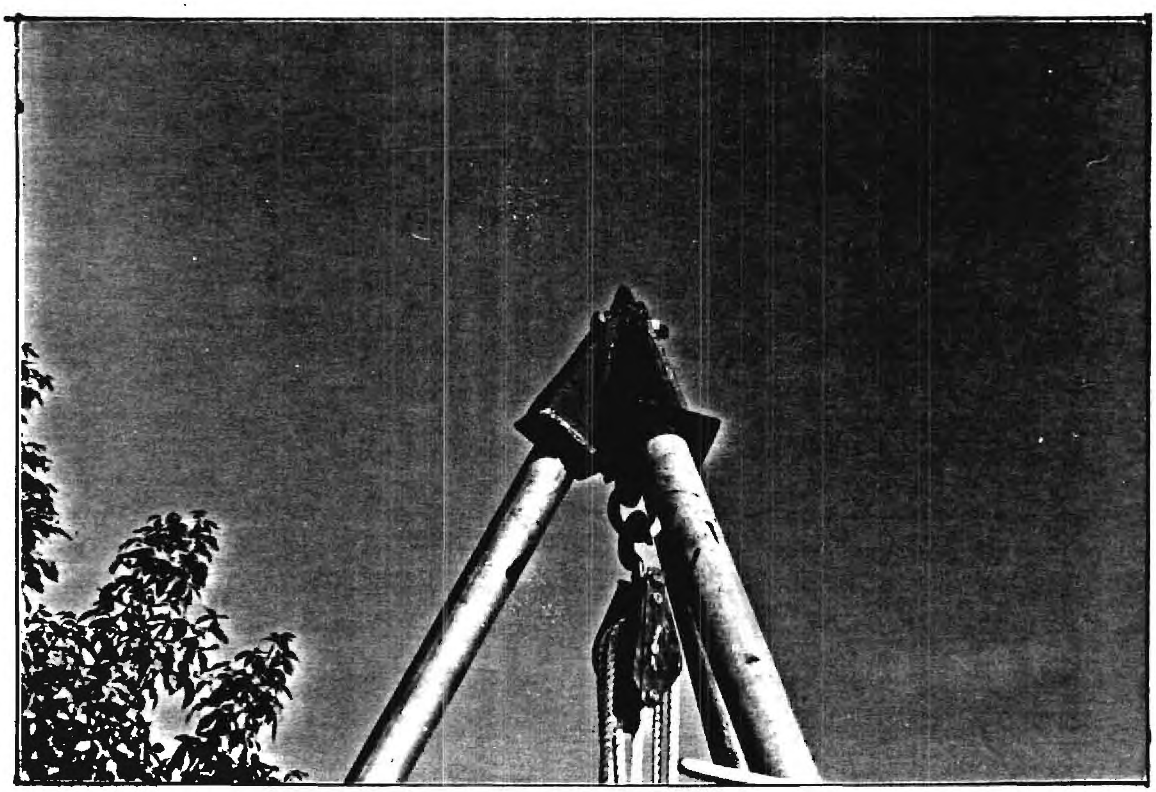
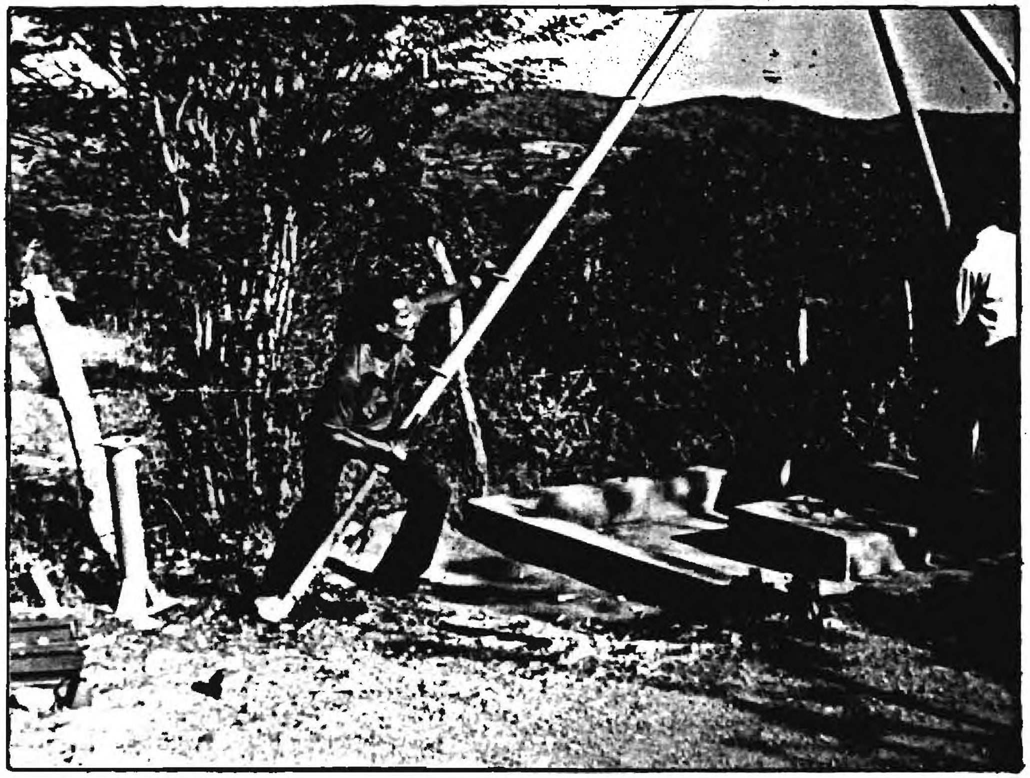


Figure 10

TRIPOD



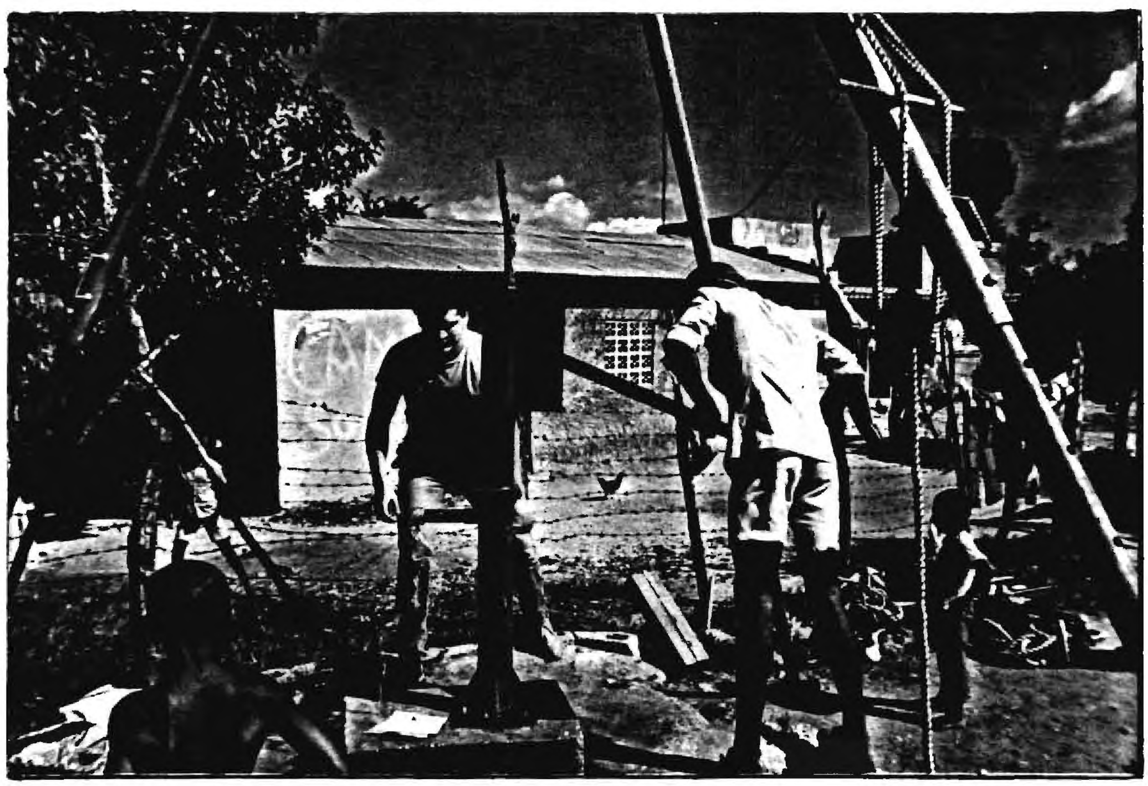


Figure 11

TRIPOD

The final prototype design (see Appendix B) was completed in November 1983. An order was then placed with Marino Hernandez and Associates in Santo Domingo. This prototype was completed in December and was used to install or remove over 25 pumps. During the installation of Pump #1 at Haina, various methods of tripod erection were tried with the following method proving most satisfactory:

1. Lay the tripod on the ground with the inner legs fully retracted and pinned, approximately 120° apart with the ends meeting near the well head. Loosely bolt the three legs together.

2. With one person lifting each leg at a point near the bolting plates, slowly lift the top of the tripod into place allowing the spike on the foot plate of each leg to dig into the ground to prevent slipping.

3. When the foot plates of the legs of the tripod are approximately 10 feet apart and the apex is approximately over the well head, tighten the connector bolt finger-tight.

4. Remove the pins from the telescoping legs and, with one person on each of the three legs, slowly lift the outer legs, one leg at a time and three holes at a time (18 inches), repinning the legs after each lift. As the three legs are consecutively lifted, make sure that the spikes on the foot plates remain in place until the apex of the tripod is approximately 16 feet above the ground. At this point secure the pins in all three telescoping legs.

5. With a plumb weight, adjust the tripod legs so that the apex is offset approximately 6 inches from the axis of the well. At this point, tighten the connector bolt with a wrench.

6. Install a shackle in the center plate at the apex of the tripod and hook the upper block of the block and tackle assembly into the shackle.

7. Hook the pipe clevis onto the lower block of the block and tackle assembly.

8. Slip the pipe clevis onto a 10-foot section of drop pipe approximately 2 feet from the coupling end.

9. Raise the pipe with the block and tackle. The lifting offset created by the pipe clevis will be compensated by the initial offset placement of the tripod. The pipe can then be lowered into the well easily.

This same method was used to erect the tripod on the remaining 15 test sites with no observed problems or accidents.

This tripod was found to require only slight modifications in order to meet the design criteria. Cost of the manufactured prototype was 235 pesos (approximately $160 U.S.). In late January 1984, SESPAS ordered four additional tripods at 325.75 pesos ($217 U.S.) each for the field units at Azua, San Juan de la Maguana, Elias Pina, and Santa Rodriguez.

Conclusions and Recommendations

This tripod design was proven easy to erect by three men in less than 15 minutes. It was also easily transported in a Datsun short-bed pickup truck with less than 3 feet extending beyond the truck bed. The safety of this tripod, when properly used, was evidenced by the accident-free installation and removal of over 25 pump and drop pipe systems. The five tripods were locally manufactured at a cost of under $225 U.S. each in a machine shop using only a power hack saw, a flame cutting torch, a drill press, and an electric welding machine.

It is recommended that this type tripod be considered for use not only in the Dominican Republic and not only for the steel hand pump but for any hand pump system and in any country where the basic materials are available.

4. FEASIBILITY OF LOCAL PUMP MANUFACTURE

USAID Design Cast Iron Pump

In 1980 SESPAS placed an order for 1,000 AID hand pumps at a unit price of 136 pesos with ETINCA, a company in Santo Domingo, after competitive bidding. Unfortunately, a decision was made whereby SESPAS would purchase some of the critical pump components such as pins, bushings, and leather cups from other suppliers and furnish these components to ETINCA. As a result, ETINCA was relieved of much of the responsibility for functioning of these components in the final pump assembly. In addition, there was no formal program of customer acceptance inspection set up for SESPAS, the agency responsible for the installation of the hand pumps. Consequently, many inferior pumps were installed which required excessive maintenance. Technical assistance was later provided to ETINCA through OTDs 1 and 48 to ETINCA by the WASH Project, a USAID/Washington centrally-funded program operated by Camp Dresser and McKee. Camp Dresser and McKee, in turn, assigned the technical assistance effort to a consultant for the International Science and Technology Institute who had previously assisted Georgia Tech on AID hand pump programs in Tunisia, the Philippines, Honduras, and Ecuador.

Another 1,050 AID hand pumps were ordered from ETINCA at a unit price of 141 pesos in July 1981 by SESPAS. These pumps were of a modified design using 2-inch PVC drop pipe and cylinder which tended to separate in the field, sometimes within one or two weeks after pump installation. There were also problems of loose bushings (not press-fit), pins and bushings not hardened to specifications, porosity in cast components, and poor machining. To make matters even worse, ETINCA advised SESPAS that there would have to be a 20% to 25% price increase in 1983 if ETINCA were to continue manufacturing AID hand pumps.

Due to quality, delivery, and price problems, it became necessary for SESPAS to consider the selection of another manufacturer to produce the AID cast iron pump. Under this IQC, Georgia Tech was asked to assist as part of a plan to:

- Identify suitable manufacturers for the AID-design cast iron pump.
- Assist in bid evaluation.
- Provide the company selected with the technical assistance necessary to mass produce high quality hand pumps with parts interchangeability.

In the first phase of this process, the USAID Mission in the Dominican Republic developed a list of ten companies. While the list certainly was not exhaustive, it was drawn from companies that represented themselves as having the capability to manufacture the AID-design hand pump. These companies were visited and their facilities evaluated during October and November 1983.

In feasibility studies conducted by Georgia Tech in other countries on local AID-design hand pump manufacture, only companies which had both foundries and machine shops were considered. A numerical rating system was designed for this type of company (foundry/machine shop). This rating allowed a potential customer to rank manufacturers' ability to produce a quality pump at various levels of production. However, Georgia Tech was unable to use this system in the Dominican Republic because there were only two foundry/machine shop combinations on the list of ten companies, and one already had demonstrated the inability to produce quality castings and machined parts. Because of these constraints, a subjective rating was given for each company based on Georgia Tech's extensive experience in both foundry and machine shop operations, and previous technical assistance to AID hand pump manufacturers in developing countries. Criteria included condition and availability of tools and equipment, management and technical skills of current employees, present line of business, floor space, quality of workmanship, and interest shown by company management. (See Appendix C for manufacturer's data sheets.)

Company Evaluations:

1. ETINCA (Equipo Tecnico Industrial, C.A.) was visited in October 1983 and its facilities evaluated. The machine shop of this company seemed adequate, with all of the machine tools necessary to produce the AID design pump. The foundry, however, was definitely sub-standard. Equipment was poor and some of the foundry practices indicated that personnel lacked several basic skills required to produce quality castings.

2. Marino Hernandez and Associates was visited in October 1983 for a facility evaluation. At the time of the visit, this company was thought to be a foundry/machine shop combination. During the visit, however, it was discovered that the foundry facilities had been removed. The machine shop facilities were primitive and appeared to be in poor repair. The floor space available for volume production was also limited. It is doubtful that this company could produce quality AID hand pumps in meaningful quantities.

3. Mantenimiento Mecanico Industrial, S.A. also was visited in October 1983. During the visit, it was immediately obvious that this company not only did not have a foundry, but that it was not set up for the production machining of iron castings. The company produces plastic injection molding tooling on a few pieces of precision machine tools. The owner indicated that he was not interested in the production of hand pumps.

4. Talleres Pichardo & Company was visited during October 1983. This company was a well managed machine shop specializing in gasoline and diesel engine rebuilding. Its machine tools were very specialized--precision pieces of equipment dedicated to engine rebuilding. The machining and assembly of cast iron pumps in this facility would not be compatible with this company's present line of business.

5. Senra Tool & Die, S.A. was visited in October 1983 and found to be a well managed and busy company. This facility had three production areas: a machine shop with a wide variety of machine tools; a fabrication area capable of cutting, assembling, and welding; and a press room equipped with several punch presses, which were mass producing metal stampings such as hinges and kitchen utensils. This company's main business is producing tools and dies for industry and internal use. It had a more than adequate heat treating facility capable of case hardening as well as through-hardening. The owner/manager of this company is an engineer, who worked for several years in the United States. This company does not have a foundry, but is capable of machining and assembling at least 500 AID hand pumps per year with a minimum of outside technical assistance.

6. Cedeno Industrial, S.A. was visited in mid-November 1983. This company had an adequate machine shop, with a variety of old but operating machine tools. It also had a large metal fabricating area capable of cutting, assembling, and welding. In addition, this company had a foundry adequately equipped to produce acceptable quality gray iron castings. In the past, this company had been recommended as a manufacturer for AID hand pumps, but lost the SESPAS contract for 1000 hand pumps to a company bidding lower. During that period, however, Cedeno had produced quality castings for the AID hand pump and still had them in storage for future sales. As part of this evaluation, ten cap assemblies (cap, fulcrum, rod end, handle, pins, and bushings) were ordered from Cedeno to determine the company's abilities in quality machining and assembly. Cedeno did not have the ability to heat treat pins and bushings, so the manager had another company produce them. Completed cap assemblies were inspected and found to meet all specifications, with above average quality. This company, with outside suppliers of pins and bushings, is capable of producing at least 500 AID hand pumps per year. However, it would require extensive technical assistance in developing quality control systems and manufacturing tooling.

7. DIMECO (Diseno Mecanico y Construcciones, C.A.) was visited in October 1983 for a facility evaluation and found to be well managed. This company had a wide assortment of machine tools appropriate for tool and die fabrication (its main business) as well as for general machining. The company had no foundry facilities. It had the capability of heat treating to specification and had a Rockwell hardness tester. This company produced high quality pins and bushings for the ten cap assemblies produced by Cedeno. DIMECO could machine and assemble castings from other sources to produce at least 500 AID hand pumps per year with minimum technical assistance.

8. Fundicion San Pedro was visited in October 1983. During the visit, it was immediately apparent that this was a small foundry without a machine shop. Facilities were small and very primitive. Production of this foundry was limited to simple shapes, such as manholes and grating, where high quality gray iron is not of concern. This facility has neither the equipment nor the skills to produce AID hand pump components.

9. Fundicion Alamo was visited during October 1983. This company is owner-managed and produces very high quality gray iron, brass, and aluminum castings to customer specifications. The company had machine shop capacity only for the maintenance of the foundry facilities. It had excellent pattern-making facilities and used up-to-date molding techniques in the foundry. This company could produce high quality gray iron and brass castings for at least 1500 AID design hand pumps per year.

10. Fundicion Reyes was visited in October 1983 and was found to be a foundry only, with no production machining capability. Observed gray iron castings were of medium quality and all simple, easily cast shapes. This company could produce low to medium quality gray iron and brass components for at least 500 AID hand pumps per year.

Conclusions and Recommendations

One of the constraints of the AID cast iron hand pump feasibility study was that the company recommended have both foundry and machine shop facilities. This constraint was placed verbally by both SESPAS and USAID/Dominican Republic. This constraint was understandable considering the recent hand pump problems brought about by several companies supplying components for the hand pump, with no one company being accountable for ultimate pump quality. Based on this constraint, Cedeno is the only foundry/machine shop investigated with the potential of producing a quality AID hand pump in significant quantities (see Table 6 for summary of companies evaluated).

If the constraint that only one company produce the pumps is relaxed, then an alternative would be to select a competent machine shop as the prime contractor for USAID hand pumps, specifying that only castings from a selected foundry be used and that the machine shop be solely responsible for ultimate pump quality.

These recommendations take into consideration only quality and ability to produce pumps in significant numbers; they do not consider the very important variable of price. For this reason, it is recommended that if and when SESPAS begins the evaluation of bids for AID design hand pumps, it utilize a technically competent outside agency to assist them in this task.

Steel Hand Pump

One of the design criteria for the steel hand pump was that it be producible in simple machine shops, using very basic machine tools and welding techniques, unlike production of the AID-design cast iron pumps which require more capital-intensive foundry processes.

Georgia Tech researchers felt that because only oxyacetylene cutting, drilling, milling, and welding processes are required, many small shops and factories in the Dominican Republic would be capable of producing this

TABLE 6

COMPANY SUMMARY

Company Name	Foundry	Machine Shop	Capability* To Do Acceptable Castings or Machining for Hand Pumps (per year)	
			500 pumps	1000 pumps
ETINCA	yes	yes	no	no
Marino Hernandez	no	yes	yes	no
Mantenimiento Mecanico	no	yes	no	no
Talleres Pichardo	no	yes	no	no
Senra Tool & Die	no	yes	yes	yes
Cedeno	yes	yes	yes	yes
DIMECO	no	yes	yes	yes
Fundicion San Pedro	yes	no	no	no
Fundicion Alamo	yes	no	yes	yes
Fundicion Reyes	yes	no	yes	no

*Companies without foundry facilities are evaluated on machining capabilities only.

Companies without machining facilities are evaluated on foundry capabilities only.

steel hand pump. Rather than becoming involved with extensive company interviews and facility analyses, Georgia Tech decided to order three steel hand pumps from each of four companies already interviewed and evaluate the resulting product. The primary objective of this evaluation was to determine producibility of steel hand pumps in the Dominican Republic.

In December 1983, Georgia Tech engineers showed the prototype pump to the four manufacturers who appeared capable of fabricating this type of pump. The manufacturers had also been given engineering sketches of the pump and components labeled in Spanish. Each prospective manufacturer examined the pumps and asked questions about the engineering sketches. Orders for three steel hand pumps were placed with each of the four manufacturers, who had agreed to quote a unit price on a lot of 100 pumps after determining material prices and direct labor costs. Manufacturers were Cedeno Industrial, Senra Tool & Die, Dimeco, and Marino Hernandez & Assoc.

1. Cedeno Industrial, S.A. was contacted in December 1983 and shown engineering sketches of the steel hand pump. Its management was also informed of the Santo Domingo supply source for the sealed ball bearings. The company indicated that it could produce this pump, so an order was placed for three pumps. These pumps were delivered in early January. Later, four additional steel hand pumps were ordered, manufactured, and found to be acceptable. A price quotation (which did not include cylinder or piston) of 294 pesos was also obtained from Cedeno. This quotation was good for only 30 days due to the unstable economy.

2. DIMECO was contacted, provided with engineering sketches of the steel hand pump, and told about supply sources for component parts. In December 1983, three steel pumps were ordered from Dimeco. In mid-January, Dimeco had not begun fabrication, so the order was cancelled.

3. Senra Tool & Die, S.A. was contacted in December 1983 and provided with engineering sketches of the steel pump. After informing Senra

about sources of supply of the sealed bearings and other components, three pumps were ordered. In mid-January it was discovered that Senra was only producing two pumps. When these pumps were delivered and inspected they were found to be of unusually good workmanship. A price quotation for the pump (less piston and cylinder) of 195 pesos was obtained for lots of 100.

4. <u>Marino Hernandez & Associates</u> was contacted in December 1983 and provided with engineering sketches and other information on supply sources for pump components. Three pumps were then ordered. One pump was delivered in mid-January and the next two pumps in early February. The last two pumps were of much better workmanship than the first pump delivered. A price quotation of 199 pesos was also obtained from Marino Hernandez for the pump, less piston and cylinder.

By January 16, only 4 of the 12 pumps ordered had been completed. Cedeno had completed three; Marino Hernandez had completed one; Senra had almost completed two but had decided not to build the third; and Dimeco had not started production. The order to Dimeco was cancelled. Because of Cedeno's timely completion and quality, this company was given an order for four additional steel pumps, so that a total of 12 locally manufactured steel pumps still would be available for field testing.

Evaluations of manufacturers of the steel pump were made in four areas: conformance to drawings, workmanship, actual cost, and delivery. Results are summarized in Table 7.

The price quotations for the steel pump varied in a surprising manner. The manufacturer of the highest quality pump, Senra, quoted the lowest price (195 pesos per pump, less cylinder and piston). Marino Hernandez, who produced the lowest quality pump of the three manufacturers, quoted the next lowest price (199 pesos per pump, less piston and cylinder) and Cedeno, who produced a pump of intermediate quality, quoted the highest price (294 pesos, less piston and cylinder). Overall, these price quotations indi-

TABLE 7

EVALUATION OF STEEL PUMP MANUFACTURERS

Manufacturer	General Conformance to Drawings	Workmanship	Actual Quote*	Delivery
Senra Tool & Die	Acceptable	Excellent	195 pesos	poor[1/]
Cedeno	Acceptable	Good	294 pesos	satisfactory
Marino Hernandez	Acceptable	Acceptable	199 pesos	poor
Dimeco	N/A	N/A	N/A	N/A

*Excluding piston and cylinder

1/ This poor delivery performance was caused to a large extent by a misunderstanding due to poor communication between Georgia Tech engineers and the owner of Senra Tool & Die.

cated that the steel pump would cost less than the AID-design cast iron pump, since a current quotation from Cedeno for the AID-design cast iron pump was 335 pesos (not including cylinder). The piston for the steel pump should cost around 22 pesos and the cylinder (24 inches of Schedule 80 PVC pipe) should cost around 3 pesos. It should be noted that it is very difficult to get cost estimates at the present time in the Dominican Republic due to the rapid rate of inflation. While the official rate of currency exchange for the peso is $1.00 U.S., the market rate has fluctuated between 1.30 pesos and 1.60 pesos per U.S. dollar during recent months. As a result, all quotations for pumps (both steel and cast iron) were valid for only 30 days.

Conclusions

Through discussions with the three test manufacturers and independent analyses of pump costs and quality, the following conclusions were reached:

1. The steel hand pump will cost less than the USAID cast iron pump.
2. The steel hand pump can be manufactured to acceptable quality levels in the Dominican Republic.
3. Because of the limited number of foundries in the Dominican Republic and the availability of many general machine shops, the steel hand pump can be produced by a far greater number of companies than the AID-design cast iron pump.

5. TRAINING MATERIALS DEVELOPMENT AND NEEDS ASSESSMENT

Development of local capabilities is a primary goal in effective technology transfer. Along with adaptation of the technology to fit local conditions, use of local manufacturing and training of human resources is often necessary. Technology improvements and development of local manufacturing capabilities for the Dominican Republic were addressed earlier. The vital link of trained personnel is addressed here. Under this work order (No. 3), Georgia Tech developed training materials for use in the field and assessed training needs in the Dominican Republic for the Health Sector II Project.

Training Materials Development

A field flipchart was developed, based on a successful model used in Honduras by the USAID PRASAR Project (a rural water supply and sanitation project). The flipchart is made of a rugged cloth material to withstand extensive use by health educators. It contains information on Health Sector II goals and objectives, plus information on health problems related to poor sanitation practices and their solutions. Health educators use the flipchart to train rural villagers when working with community health committees and in training volunteers for maintenance and repair of hand pumps and latrines.

Georgia Tech developed the following training manuals for use in the Health Sector II Project:

- The Hand Pump Installation, Maintenance and Repair Manual for Health Educators was designed for a five-day workshop by Terrence Moy, P.E., and translated into Spanish by Henry Van, Ph.D. The manual contains 17 sessions with topics that range from hand pump operation and installation to well disinfection and the training of others. All of the sessions are participant-oriented and emphasize a hands-on approach with numerous demonstrations, group practices and actual field experiences.

- The Hand Pump Installation, Maintenance and Repair Manual for Community Members is a collection of six individual handouts excerpted from the Hand Pump Installation, Maintenance and Repair Manual for Health Educators. The handouts are designed to guide the participant with the most basic skills through the procedures needed to install, maintain and repair the AID deep-and shallow-well hand pump.

- The Latrine Construction, Installation and Maintenance Manual for Health Educators was also designed for a five-day workshop by Terrence Moy, P.E., and translated into Spanish by Henry Van, Ph.D. As with the other two manuals, this manual provides participants with hands-on experience. This is done through the use of an outline for training in topics that range from basic sanitation theory to concrete mix proportioning. All of the sessions emphasize the active participant approach by utilizing small group discussions, presentations and actual field experiences.

Training Needs Assessment

A training needs assessment was also completed during the five months that Georgia Tech project personnel spent in the Dominican Republic. Training needs were investigated throughout the Health Sector II Project levels down to the community level, and concentrated on looking at the responsibilities and skills of the persons to be trained, observing their current performance, and determining what training would be required to help them perform their jobs effectively.

Health educators are the active agents in the implementation of program components in rural communities. Currently, responsibilities of the health educators include:

- o Conducting sanitary surveys of the selected communities;
- o Organizing community meetings to promote Health Sector II Project components and to provide health education.
- o Promoting community participation in project components for:
  - hand pumps (installation, maintenance and repair)
  - latrines (manufacture, installation, and maintenance)
  - gravity-fed water systems (aqueducts).
- o Planning and conducting training workshops for other health educators and community members in:
  - hand pump installation, maintenance and repair
  - latrine construction, installation, and maintenance
  - aqueduct maintenance and repair.
- o Distributing family potable water containers.

At present all health educators have received training in three areas--hand pumps, latrines, and health education. However, new health educators will be hired in the future to assist with expanded duties. To perform well and maximize health benefits to the communities served by Health Sector II, these new individuals will require training.

The planning and conduct of training workshops for health educators and for community members is a relatively recent task. While all current health educators have completed the technical workshops, they have only begun presenting workshops themselves since December 1983. Georgia Tech personnel assessed the performance of these health educators as trainers at the initial workshops presented for other health educators. However, due to time constraints, Georgia Tech project personnel completed only limited evaluation of their training for community workers.

Observations of Health Educators as Trainers

Health educators currently are conducting two levels of training--for other health educators and for community volunteers. Georgia Tech project personnel observed two workshops conducted for other health educators on hand pump installation and four workshops for community volunteers on hand pump maintenance. In addition, Georgia Tech project personnel conducted a workshop for health education on use of the hand pump installation tripod.

Georgia Tech personnel also advised the health educators that would conduct the training on certain basic training techniques. These included:

- o Establishing an informal setting with the trainees.
- o Using color markers to highlight specific points of important interest.
- o Hanging sheets with written information around the room for later reference.
- o Teaching trainees not to memorize pump part names but to first understand their function and then the names.
- o Allowing trainees during the practice sessions to do the work themselves.
- o Asking for questions at the end of each section of a session and permitting questions from trainees at all times.

These training techniques were followed by the health educator trainers in all the workshops observed by Georgia Tech personnel. Observations and needs identified are summarized below.

Training of Other Health Educators in Hand Pump Installation

Workshop 1

Two trainers presented a two-day workshop on hand pump installation to six health educators who had no prior training in the Santiago Rodriguez location on February 7 and 8, 1984. Trainers followed their training manual well, and participants demonstrated an understanding of material in the first theory session by answering most questions correctly and assembling the pump components in proper order. Overall problems which had a negative effect on the theory session presented on February 7 were:

1. The trainers did not have their training materials for the theory presentation ready when the course was scheduled to start.
2. Tools to be used for demonstration were poorly maintained, with some missing.

A practice session was completed by trainees in installation of a pump for a 63-foot well with a static water level of 36 feet on February 8 in the community of Tres Palmas. While trainees performed fairly well in lowering the pipe and rod and connecting the pump, they had difficulty with:

1. Organizing materials and measuring, cutting, and threading of pipe.
2. Using the tripod, since trainees had no prior knowledge of it.
3. Using hand tools.
4. Using only one group leader during installation.

Overall, participants felt that with more supervised practice they could install pumps on their own.

Workshop 2

Two different health educator trainers presented a similar hand pump installation workshop to five health educators who had no prior training on February 9 and 10, 1984, also in Santiago Rodriguez. During the morning session, the Georgia Tech observer emphasized the importance and rationale of training community members since this point was only slightly mentioned by the trainers. Although both trainers were nervous, and thus slightly disorganized, training went well. Trainees demonstrated knowledge of the course material covered in the theory session by their participation in answering questions and assembling the pump.

Since trainees had observed the previous workshop participants install a pump, their installation went smoother on February 10. Using the tripod, trainees installed a hand pump in a well 84 feet deep, with a static water level of 48 feet at the community of Hipolito Billini. Trainees performed well in lowering pipe and rod and connecting the pump, but still needed more training with the tripod and use of hand tools.

Joint Practice Session

Since the health educators participating in the training would in the future train community members, the more field experience they had the more confident they would be in the training. Each group of trainees installed a second pump on February 13 in wells close to each other so that both installations could be observed. Since both installations occurred simultaneously only one group used the tripod. The pumps were installed in the community of Aguacate on February 13. Aguacate 1, installed without a tripod, had a total depth of 57 feet and a static water level of 20 feet. Aguacate 2, installed with a tripod, had a total depth of 64 feet and a static water level of 44 feet. Installations were conducted rapidly and with ease because the training crews were organized, with each trainee doing his specific task. (The pipe and rod had been cut the previous Saturday.)

Even with the additional practice/observation in the use of the tripod, participants and trainers need more instruction in proper procedures. Trainees from both workshops, however, were confident that with more practice they would be able to install pumps on their own.

Training of Community Members in Hand Pump Repair

Workshop 1

Two health educators presented a two-day community workshop in repairing pumps to six community members in the Carreton area on February 1 and 2, 1984. The theory session on February 1 was presented in an orderly manner following the training manual. Georgia Tech personnel interrupted on a few occasions to clarify specific points. One minor problem was that trainees had difficulty in understanding technical terms that were new to them.

In the practice part of the workshop on February 2, the trainees repaired two hand pumps. The first was a standard AID model with 1 1/4-inch drop pipe located in Sabana Larga. The trainees replaced a broken check valve and piston. The second pump was a modified AID pump with PVC drop pipe. At this site the trainees replaced a broken check valve.

The Georgia Tech team observed that:

1. The trainees were well organized by the trainers and worked as a team.
2. A team leader from the trainees emerged naturally.
3. At the end of the workshop trainees were enthusiastic and confident of their abilities to repair pumps.

With more practice supervised by health educators, these community members will be able to repair pumps by themselves.

Workshop 2

Two health educator trainers conducted a two-day workshop on hand pump maintenance and repair for five community volunteers in the area of San Juan de la Maguana in the community of La Ceiba. While the trainers were initially nervous, they became more confident during the workshop. The theory session was presented effectively as evidenced by the trainees' knowledge of pump parts and correct assembly of the pump during the session. However, a section on different pump designs used in the Dominican Republic presented problems because:

1. Information was too detailed for an initial presentation.
2. Technical terms new to the trainees were used without full explanation.

During the practice session, where trainees repaired pumps at two sites, the Georgia Tech team observed that:

1. The trainers worked as a team.
2. A team leader for the trainees emerged naturally, due to his influence in the community.
3. Transportation problems occurred.
4. Only shallow-well pumps were repaired, as no deep well was conveniently close to the community.

Trainees were highly enthusiastic and confident of their abilities to maintain and repair hand pumps.

Workshop 3

Due to a communications failure, 11 trainees from three different communities had been scheduled for a workshop in La Estancia on February 8 and 9, 1984. It was decided that while practice sessions would have to be scheduled in smaller groups, all 11 of the trainees could be handled in the theory session. The session went very well, with the following observed:

1. Trainers were well-prepared with good drawings, sketches, and a flipchart listing workshop objectives.
2. Trainers were enthusiastic and dynamic, holding trainees' attention.
3. Training took place in a school, so the atmosphere was very conducive to learning.

Trainees were divided into smaller groups for the practice sessions. Only the first group, who repaired two pumps, was observed by a Georgia Tech project member. Observations during repairs to both pumps revealed that:

1. Trainees had difficulty using some tools.
2. Both trainers and observers became too involved in the repair process.
3. Casual passers-by interfered with the session by making suggestions and giving advice.

After completion of repairs, trainees reported that they felt competent, and would further improve their competency with more practice. Several trainees, however, would have preferred more extensive theory and practice.

Workshop 4

Two health educator trainers conducted a workshop for three community volunteers in Azua on February 13 and 14, 1984. A fourth trainee cancelled due to illness. Due to time limitations, only the theoretical session of February 13 could be attended, so observations apply to trainer presentation. Problems were seen in:

1. Use of elaborate language rather than a vocabulary geared to the audience.
2. Sketches and drawings too schematic and symbolic.
3. The demonstration pump had bad pins and bushings, so once taken apart it could not be reassembled.

Because trainees had not yet had any "hands-on" practice, they could not state whether they would be able to repair hand pumps in the field. As indicated above, due to time limitations Georgia Tech personnel were unable to observe the practice session of February 14.

Georgia Tech Training of Health Educators on Tripod Use

A two-day workshop was scheduled on the use of the tripod for pump installation on February 10 and 11, 1984, in Elias Pina. However, due to time limitations, only the theory session was presented covering:

- Pre-installation
- Raising the tripod
- Proper use of the tripod, pipe clevis, and pipe clamp
- Installation of the pump

Since the practice session provides necessary hands-on experience the participants cannot be considered trained in installing pumps with a tripod until this session is completed.

Identified Needs

Training needs were identified for project and community personnel. Within the Health Sector II Project, personnel should be trained in those methods, techniques, and technical skills required for workshop presentation and health education. By training health educators as trainers, three levels of expertise are derived:

- Unit supervisors, who can provide training to the health educators.
- Health educators, who can provide training to the communities.
- Community workers, who are capable of performing the necessary tasks and providing on-the-job training to other community members.

As new training aids such as the field flipchart are implemented, health educators will require further "training as trainers". Because skills are locally "owned", health educators will need to develop innovations in training methods and training aids. Transfer of these technologies to other project members also will require training. To achieve this objective, the project needs both technical training and "training as trainers" for health educators in:

- Hand pump installation, maintenance and repair
- Latrine construction, installation and maintenance
- Aqueduct maintenance and repair
- Promotion and health education, emphasizing the use of the field flipchart
- Quality inspection of hand pumps, latrines, and tools.

Trained community workers are essential to the continuation of project services and achievement of goals. The Health Sector II Project is currently operating on an extension and may not be integrated into SESPAS. This severe time constraint necessitates that training be both efficient and effective. Community members need technical training in:

- o Hand pump installation, maintenance and repair
- o Latrine construction, installation, and maintenance
- o In those communities with gravity-fed water systems, aqueduct maintenance and repair
- o Quality inspection of hand pumps, latrines, and tools.

Particularly with new skills, performance may be uneven. To avoid the development of bad habits, deficiencies will need to be addressed immediately. As Health Sector II personnel pinpoint poor performance, a judgment can be made regarding further training/retraining needs (group, individual, simple feedback, etc.).

Recommendations for Training Materials Development

Development of a Promotion and Health Education Training Manual for the health educators is needed. Currently, Health Sector II is developing a promotion and health education field flipchart adapted from Honduras' Rural Water and Sanitation Project (PRASAR). It is recommended that health educators integrate use of this flipchart into the Promotion and Health Education Training Manual.

Slide presentations in all the above areas are needed to serve as training aids. To date, three plexiglass hand pump training cylinders have been assembled by the authors to serve as training aids in the hand pump workshops. It is recommended that at least 20 more of these training cylinders be assembled. Each unit area should have at least three. Unfortunately, the plexiglass pipe is not available in the Dominican Republic and must be imported from the U.S. (Length of each cylinder is approximately 18 inches, with an internal diameter of 2.75 inches and an external diameter of 3 inches).

Recommendations for Training Workshops

Health educators should continue to receive training through a series of workshops in the project component areas. Workshops should be from two to five days in duration; longer workshops are difficult due to health educators' heavy workload. Health educators, in turn, should continue to train community caretakers in hand pump installation, maintenance and repair; latrine construction, installation, and maintenance; hand pump and latrine quality inspection; and tool maintenance.

Recommended workshop designs for training of health educators are:

PROMOTION AND HEALTH EDUCATION

- Duration: Three days

- Location: Unit area

- Schedule: (See Table 8.)

- Coordination: This workshop should be given for unit heads, supervisors, and health educators. Unit heads and supervisors must schedule the workshops to minimize project downtime. These workshops should be given on a regular basis as the project workload permits.

- Number of participants: 12 maximum

HAND PUMP INSTALLATION, MAINTENANCE, AND REPAIR

- Duration: Two days

Table 8

PROMOTION AND HEALTH EDUCATION WORKSHOP

TIME	DAY 1	DAY 2	DAY 3
8:00	Introduction to the Workshop	Role Play: Communication	Water Storage & Transportation
9:00	Description of Health Sector II		Community Organization
11:00	Communication Skills	Water Supply & Nutrition	Water Purification
12:00	Lunch	Lunch	Lunch
1:00	Health Education & Promotion Flipchart Use	Waterborne Diseases	Solid Waste Disposal
2:00			Problem Areas
3:00	Health, Disease & Sanitation	Movies & Discussion	Movies & Discussion

- Location: Unit area, with lectures held in the local clinic or other suitable buildings. Practical field work should be held in a community where participants can install or repair a hand pump.

- Schedule: (See Table 9.)

- Coordination: Unit heads, supervisors, and health educators should meet with the community health committees at least twice prior to the workshop to discuss the purpose of the workshop, attendance, timing, site, transportation, and other relevant topics.

- Number of participants: 4

LATRINE CONSTRUCTION AND INSTALLATION

- Duration: Five days

- Location: Unit area, with lectures held in a center that has sufficient outside space for the slab and riser construction practice. Installation should be held in a community.

- Schedule: (See Table 10.)

- Coordination: Unit heads, supervisors, and health educators should meet with the community health committee at least twice prior to the workshop to discuss the purpose of the workshop, attendance, timing, site selection, pit preparation, sand and gravel availability, transportation, and other relevant topics.

- Number of participants: 12

Table 9

HAND PUMP INSTALLATION, MAINTENANCE, AND REPAIR WORKSHOP

TIME	DAY 1	DAY 2
8:00	Introduction to the Workshop	Field Practical on Hand Pump Installation and Repair
9:00	Health Sector II Background	
10:00	Hand Pump Components	
10:30	Tool Use and Maintenance	
11:00	Practical on Assembling and Disassembling a Hand Pump	
12:00	Lunch	Lunch
1:00	Maintenance and Repair of Hand Pumps	
2:00	Cutting and Threading Pipe and Rod	Field Practical on Hand Pump Installation and Repair
3:30	Disinfection	
4:30	Problem-Solving and Discussion	

Table 10

LATRINE CONSTRUCTION AND INSTALLATION WORKSHOP

TIME	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
8:00	Intro. to the Workshop	Construction of a Slab & Riser: Field Practical	Sanitary Survey: Field Practical	Latrine Constr. Site Evaluation: Field Practical	Latrine Install: Field Practical
9:00	Health, Sanitation & Latrines				
11:00	Community Participation				
12:00	Lunch	Lunch	Lunch	Lunch	Lunch
1:00	Local Beliefs & Customs	Design of a Latrine	Types & Selection of Latrines	Planning a Latrine Constr. Project	Review of Latrine Constr. Project
3:00	Community Mobilization & Info	Latrine Maintenance & Repair	Types of Latrine Shelters	Types of Latrines for Problem Areas	Workshop Evaluation & Closure

In addition to these workshops, health educators have demonstrated a need for training in hand pump and latrine quality inspection. This information should be transferred to community caretakers, whether informally or as part of the hand pump and latrine workshops.

TRIPOD

Due to time limitations complete instruction in the working of the tripod was not finished by Georgia Tech. Three pumps installed in the Santiago Rodriguez area were made with the tripod. At least six other supervised installations should be made by educators before the educators are allowed to install pumps by themselves. During the installation of the three pumps with the tripod there were doubts about the specific duties of each team member, and several safety rules were broken even though Georgia Tech personnel clarified team member duties and pointed out the safety rules beforehand. However, with supervised installations the educators will build confidence and increase their efficiency.

A manual, in Spanish, now needs to be prepared outlining the specific procedure in the use of the tripod, explaining the duties of each team member, and illustrating these duties.

INSTALLATION PREPARATION

The health educators should be trained in quality inspection of pumps, checking all components of the pumps before installation to assure that no pumps are installed with faulty parts. The training should include checking casting porosity, base threads, pins, bushings, etc.

6. RECOMMENDED APPROACH TO INSTALLATION AND MAINTENANCE SYSTEM

From the beginning of the Health Sector II Project in 1980 until June of 1983, installation of hand pumps and latrines was by private contractors. These contractors were paid by the number of units installed. Although this method of incentive did increase the speed of installation, quality of the work performed diminished considerably. Contractors' primary concern was to install as many units as possible per day, without regard to quality of the work (the more units they installed the more money they made).

In April 1983, health educators began to be formally trained by Georgia Tech personnel in latrine construction, installation, and maintenance under the WASH Project's OTD No. 143. This was followed by additional training during October, November, December, and February (1984) under Georgia Tech's IQC in latrine construction; hand pump installation, maintenance and repair; and health education. Based on this training, Health Sector II Project management has made the decision to have health educators perform hand pump installation, maintenance, and repairs and to install latrines with community participation.

This approach has worked well and the authors of this report highly recommend its continuance. Health educators now are successfully promoting latrine construction, and then completing the installation with community participation. Using the same approach, health educators now are conducting training of village caretakers in hand pump installation, maintenance, and repair.

At this point in time a system for installing and maintaining hand pumps and latrines must be encouraged to take advantage of the very positive aspects of the recent training in the Dominican Republic. The following system is based on past Health Sector II Project experience and discussions with the various individuals involved at different levels. This system attempts to avoid past mistakes and incorporates those ideas proven successful in the field. It must be recognized, however, that such a program should start slowly, gradually accelerating as the health educators become more proficient in training, thus transferring the technology to new health educators and communities. The system is dependent, also, on assuring that the health educators and village caretakers develop sufficient expertise and confidence. So far, field observations by Georgia Tech clearly indicate that with sufficient training and assistance, communities have the potential for becoming largely self-sufficient in terms of repair and maintenance.

The policy to be adopted regarding installation is crucial. If the Health Sector II Project attempts to continue the contractual approach of installing hand pumps and latrines at the same time as communities are actively participating in installation, problems will arise. Communities may become demoralized if they find that some neighbors had gotten their hand pumps and latrines without effort on their part. Conversely, those communities not actively participating may feel slighted. Thus, the policy must be homogeneous throughout the project area.

Promotion and Health Education

Health educators should be responsible for obtaining community participation, aided by use of prominently displayed posters and the field flipchart prepared by SESPAS. Once a health educator has successfully completed his/her promotion and initial health education activities, he/she should act as advisor to the health committee in each community and provide general support. It is important, however, that the health committee make its own decisions.

Health educators should also be responsible for conducting a program of promotion and health education through group meetings and house visits. The field flipchart will be especially useful in these activities. Satisfied communities in turn will become effective promoters, assisting in increasing compliance in their own and other villages. To a certain extent, motivation of Health Sector II personnel may determine the success or failure of the promotion and health education activities. Thus, only highly motivated, well-qualified individuals should be used for this job.

Training

The training program recommended in Chapter 5 should be implemented. Further, based on two alternatives regarding the future of the Health Sector II infrastructure, the following is recommended:

- If the Health Sector II Project is integrated into SESPAS, additional technical assistance should be given to guide the project personnel into a more detailed training program, especially in all aspects of hand pumps and in promotion and health education.

- If the Health Sector II Project is not integrated into SESPAS, training in hand pumps and latrines should continue as it is now being conducted. Health educators previously trained during April, October, and November 1983 should train other health educators and community workers. Workers from every community should be trained before the end of the project.

Independent of the above conditions, training of the communities in hand pump maintenance and repair should continue to be performed in the field by health educators. The success of the hand pump program depends on the quality of training given those communities to make them self-sufficient with respect to maintaining their water supply and excreta disposal systems.

Hand Pump Installation

Proper installation of hand pumps is required to avoid operational problems which result in excessive maintenance. For this reason, adequate training in hand pump installation is important. After training, installation of hand pumps can be performed by community workers throughout the project area with the help of the health educators. Each health educator should present a work plan for installing hand pumps to his/her supervisor. Supervisors then would report to the unit head, who will coordinate all the installation activities in the area. In this manner, proper priorities can be assigned to all the tasks and a coordinated schedule prepared. The unit head would coordinate transportation, materials, and personnel according to the schedule.

Tools

Minimum tools required to install the AID design hand pump are:

- 3 24-inch pipe wrenches
- 1 18-inch pipe wrench
- 1 adjustable wrench
- 1 screwdriver
- 1 regular pliers
- 1 pressure pliers
- 1 9/16-inch open and close wrench
- 1 pipe clevis
- 1 hacksaw
- 1 regular hammer
- 1 measuring tape (100 feet)
- 100 feet of 1/2-inch nylon rope (not plastic or manila)
- 1 die set for 7/16 to 2 inches
- 1 tripod
- 2 two-wheel pulley blocks
- 1 oiler
- 1 flat file
- 1 can chlorine (HTH)
- 250 feet of 1/8-inch line with weight (for determining well depth)
- gloves
- wire brush

Transportation

Each health educator currently has a motorcycle for transport to the community. When the health educator installs pumps, however, a pickup truck will be required to transport the tripod and distribute the hand pumps, rod, pipe, and tools. Each unit must have at least one pickup truck. Distribution of materials such as pipe, rod, and hand pumps can be done ahead of time, so that only the tools will have to be assembled for each installation.

Recordkeeping

Each health educator should be responsible for completing a form for each installation, recording:

- community and its location
- date of installation
- name of the individual doing the installation
- type of hand pump installed
- total depth of well
- depth of the column of water in the well
- total quantity and type of drop pipe used
- total quantity of plunger rod used
- type of foot valve used
- date of chlorination

The original installation report should be sent to the central coordinating office in Santo Domingo, and one copy should be filed in the unit office.

Latrine Installation

Installation of latrines should be conducted by the health educators with the assistance of the communities. Site selection should be conducted by the health educators, following the selection criteria outlined in the latrine construction and installation training manual prepared for Health Sector II.

To date, all the health educators have been trained in latrine construction. Since this training, health educators have been manufacturing and installing latrines with community participation, and with very good response. The Health Sector II Project is in the process of contracting the manufacture of 50 latrine molds for distribution among the four units. Each unit should be responsible for overseeing construction of the required latrines by community workers. In training community workers, health educators should use the same manual used to train co-workers.

Each health educator should be responsible for programming this activity and reporting plans to his/her supervisor. The unit head should approve the final latrine construction schedule, being careful to coordinate these activities with the hand pump installation and health education activities.

Tools

Minimum tools required to construct a simple pit latrine are:

- 2 shovels
- 1 hammer
- 1 wheelbarrow
- 1 3-inch paint brush
- 1 3-foot measuring tape
- 1 saw
- 1 pick
- 1 bucket
- 1 trowel

Transportation

Transportation should be handled in the same manner as with the hand pump installation. All transportation of the tools and molds should be coordinated by each unit head. These items can be transported in a pickup truck, while the health educator can ride his/her motorcycle to the site. All slabs and risers for a particular community should be constructed at one time to avoid excessive need for transporting tools and materials.

Recordkeeping

Each health educator should be responsible for recording the following information upon completion of each latrine installation:

- name of the community and its location
- name of health educator
- name of each family which installed a latrine
- number of slabs and risers constructed
- number of cement bags used
- any additional comments the health educator deems important for the program, such as soil problems, high water table, and unavailability of local materials.

These records should be kept in the central coordinating office in Santo Domingo with a copy filed in the unit office.

Maintenance

The primary goal of the hand pump and latrine maintenance program is to develop community capability for routine preventive maintenance and repair. To accomplish this goal, promotion and health education must be strongly emphasized. Maintenance requirements for the AID-design hand pump and the simple pit latrine have been carefully outlined in great detail in the manuals prepared in Spanish for Health Sector II personnel. Pictures, diagrams, and forms are included in these manuals, which can serve as permanent references within each community.

The proposed organization of the program avoids the fatal assumption often made by rural water and sanitation programs--that the local community will somehow maintain the hand pump water supply or the latrine. Since limited resources are available to the Government of the Dominican Republic, preplanning must assure that maintenance costs of the Health Sector II hand pump and latrine program will be covered.

Hand Pumps

In order for a community-based hand pump program to be successful, villagers must be aware of the benefits of the program and be trained in proper hand pump maintenance and repair techniques. Maintenance includes the inspection, lubrication, testing, and overhauling of hand pumps at scheduled intervals. While minor repairs can sometimes be scheduled, major repairs must be completed immediately.

Installation, maintenance, and repair of hand pumps is now being supervised by Health Sector II health educators in each of the four project areas (Azua, San Juan de la Maguana, Elias Pina, and Santiago Rodriguez). At the same time, community workers are being trained in hand pump installation, maintenance, and repair. Upon completion of the Health Sector II Project in October 1985, communities served by hand pumps should be self-sufficient in maintaining the hand pumps.

Maintenance of hand pumps should be the responsibility of the health committee in each community, which also is responsible for collecting a hand pump user maintenance and repair fee. The health committee should select two or three volunteers from the community which will be trained by the health educators in a two-day workshop in hand pump installation, maintenance, and repair. These individuals should be responsible for performing routine maintenance and repair of the pumps when necessary.

Volunteers should have an aptitude for working with tools and, most importantly, interest in helping the community.

A fee of 0.50 pesos per family per month is being collected by the health committees for hand pump maintenance and repair. However, if communities are to assume all responsibility for maintaining and repairing the hand pumps, some communities will not be financially able to purchase all the necessary tools, equipment, and spare parts required to maintain and/or repair their hand pumps. Some communities have already expressed interest in sharing the cost of the most expensive items. When a community cannot afford all the necessary equipment, it is recommended that several communities pool their efforts and economic resources.

Shared equipment can be stored in a selected place and checked out as needed through use of a sign-out system. Upon completion of the maintenance/repair activities, the checked-out items should be returned to the central storage area. Health Sector II personnel agree that the health committees are the best community organizations to coordinate these activities.

The importance of adequate promotion and health education cannot be overestimated. To make this self-help community system work, promotion and health education must be energetically pursued, as the resulting motivation within the communities must last far beyond the end of the project.

Hand Pump Spare Parts Supply

At present, hand pump spare parts are being sold at cost to health communities by the Health Sector II Project. The project purchases the spare parts from three manufacturers (Cedeno Industrial, Marino Hernandez, and ETINCA). Each of the four unit areas has a small warehouse where spare parts are stocked. When the Health Sector II Project ends, however, communities will continue to need a supply of spare parts to maintain and repair their hand pumps. There are several alternatives to meet this need:

- Communities may organize to form a cooperative or consortium to negotiate the price of spare parts with hand pump manufacturers and assure their availability. In this manner, communities would be able to purchase at wholesale price and protect the supply of such components. The community cooperative would, under this alternative, select several individuals for training in quality inspection which could be accomplished through the Health Sector II Project before it ends. This is the most desirable alternative.

- The Secretariat of Health and Public Assistance may continue to purchase spare parts from available manufacturers and keep the more commonly used components stocked in the rural clinics. The rural clinics would sell the spare parts to the health committees. Funds collected would be channeled back to the designated SESPAS department for the purchase of more spare parts. SESPAS would need two or three individuals trained in hand pump spare parts quality control and acceptance, and one individual in charge of supervising the spare parts supply system. However, SESPAS has financial and infrastructural limitations that make the probability of implementing this alternative very low.

- Each individual community health committee could negotiate and purchase spare parts from one or more manufacturers. Prices for single units are higher, so this is the least desirable alternative.

Latrines

At present, communities are beginning to construct and install their latrines with the help of the health educators. The Health Sector II Project plan is to continue this approach. Training on latrine maintenance is included with the training on latrine installation that health educators are giving to the communities. Field inspections by Georgia Tech personnel have validated the positive results of this approach, and its continuance is encouraged.

APPENDIX A

HAND PUMPS INSTALLED UNDER HEALTH SECTOR II PROJECT

SESPAS

HEALTH SECTOR II
NUMBER OF HAND PUMPS INSTALLED BY COMMUNITY
PERAVIA - AZUA UNIT
JANUARY 1984

MUNICIPALITY	COMMUNITY	# OF PUMPS INSTALLED
TOTAL.........		248
BANI	CARRETON	20
BANI	LOS PINOS	6
BANI	LOS MAYALES	4
BANI	SABANA LARGA	6
BANI	EL TIBICI	1
BANI	ARROYO CANO	3
BANI	LA CABRIA	6
BANI	LA GINA	3
BANI	LAS TABLAS	6
BANI	LA CURVA	2
BANI	EL ABEY	1
BANI	RANCHITO	5
BANI	RINCON BELLACO	1
BANI	LA MALLITA	7
NIZAO	GUALEY	9
NIZAO	LOS ROCHES	4
SAN JOSE DE OCOA	ARROYO PALMA	4
SAN JOSE DE OCOA	JENGIBRE	3
SAN JOSE DE OCOA	LA AGUITA	4
SAN JOSE DE OCOA	LOS ANGELITOS	2
SAN JOSE DE OCOA	ARENOSO	2
SAN JOSE DE OCOA	LAS BARRAS	8
SAN JOSE DE OCOA	VENGAN A VER	2
SAN JOSE DE OCOA	OJO DE AGUA	3
SAN JOSE DE OCOA	LOS RANCHITOS	6
SAN JOSE DE OCOA	LA TORONJA	3
AZUA	HIGUERITO	2
AZUA	BARRO EN MEDIO	6
AZUA	LOS PANIAGUAS	1

MUNICIPALITY	COMMUNITY	# OF PUMPS INSTALLED
LAS CHARCAS	BOQUERON	3
LAS CHARCAS	MONTE LA GUARDIA	1
YAYAS DE VIAJAMA	VIAJAMA	11
YAYAS DE VIAJAMA	OREGANO GRANDE	13
PADRE LAS CASAS	EL FUNDO	1
PADRE LAS CASAS	EL COROZO	5
PADRE LAS CASAS	LA SIEMBRA	10
PADRE LAS CASAS	LOS CAMBRONES	3
PADRE LAS CASAS	EL DERRUMBAO	5
PADRE LAS CASAS	LA MESETA	1
PADRE LAS CASAS	LOS NARANJOS	1
TABARA ARRIBA	ARROYO GUAYABO	7
TABARA ARRIBA	AMIAMA GOMEZ	4

SESPAS

HEALTH SECTOR II
NUMBER OF HAND PUMPS INSTALLED BY COMMUNITY
SAN JUAN UNIT
JANUARY 1984

MUNICIPALITY	COMMUNITY	# OF PUMPS INSTALLED
TOTAL.........		487
SAN JUAN	HATO DEL PADRE	13
SAN JUAN	LOS CALLEJONES	1
SAN JUAN	EL CAJUIL	7
SAN JUAN	TIERRA PRIETA	5
SAN JUAN	EL HATO	7
SAN JUAN	CHALONA	1
SAN JUAN	BO. DANNIFICADOS	4
SAN JUAN	SOLORIN	4
SAN JUAN	MARIA DIONICIO	1
SAN JUAN	BAYAHONDITO	2
SAN JUAN	EL ZAJON	1
SAN JUAN	SABANA PIEDRA	3
SAN JUAN	KM. 11	2
SAN JUAN	KM. 9	3
SAN JUAN	LAVAPIES	3
SAN JUAN	EL ZAJONCITO	2
SAN JUAN	LA CANA	4
SAN JUAN	LOS ARROYOS	2
SAN JUAN	EL PRADO	1
SAN JUAN	LA GARITA	5
SAN JUAN	CARGAGUAL	1
SAN JUAN	MAGUANA ABAJO	1
SAN JUAN	LA PINA	1
SAN JUAN	HATO NUEVO	12
SAN JUAN	CARPINTERO	3
SAN JUAN	EL CIRUELITO	4
SAN JUAN	LA PENA	1
SAN JUAN	BATEY CHIQUITO	3
SAN JUAN	EL BATEY	6
SAN JUAN	LAS CHARCAS DE GARABITO	1
SAN JUAN	EL CACHEO	2
SAN JUAN	EL HATICO	1
SAN JUAN	LA CULATA	1
SAN JUAN	CUENDA	5
SAN JUAN	LAS YAYAS (Buena Vista)	7
SAN JUAN	LAS PALMAS	3
SAN JUAN	BOCA DE LA ESTANCIA	4
SAN JUAN	CHALONA ABAJO	1
SAN JUAN	LOS TAMARINDO	3
SAN JUAN	LAS CANITAS	4
SAN JUAN	LOS CERROS DEL OTRO LADO	3
SAN JUAN	EL OTRO LADO	2
SAN JUAN	SABANA DE MOGOLLON	7

MUNICIPALITY	COMMUNITY	# OF PUMPS INSTALLED
SAN JUAN	LOS CERROS	4
SAN JUAN	SAN RAMON	4
SAN JUAN	HATO ABAJO	4
SAN JUAN	LOS MATES	1
SAN JUAN	PUNTA CANA	7
SAN JUAN	ARROYO LORO	14
SAN JUAN	EL CIRUELO	9
SAN JUAN	AROMAL	6
SAN JUAN	ARROYO LORO (Hato Viejo)	7
SAN JUAN	BARRANCA	7
SAN JUAN	LOS RINCONES	1
SAN JUAN	SUAREZ	1
SAN JUAN	LOS FUNDOS	3
SAN JUAN	LAS CHARCAS VIEJAS	5
SAN JUAN	EL HATICO (GUANAL)	3
SAN JUAN	BUENA VISTA	4
SAN JUAN	ASIENTO DE LUISA	4
SAN JUAN	RINCON ABAJO	1
SAN JUAN	LOS PORTUGUESES	7
SAN JUAN	MABRIGIDA	4
SAN JUAN	LA HIGUERA	1
SAN JUAN	CABEZA DE MUERTO	2
SAN JUAN	NORIA VIEJA	6
SAN JUAN	PEDRO SANCHEZ	9
SAN JUAN	LA CEIBA	5
SAN JUAN	HATO DEL PADRE ABAJO	3
SAN JUAN	HATO DEL PADRE ARRIBA	3
SAN JUAN	LAS CARRERAS (C. ARRIBA)	2
SAN JUAN	CERROS DE SAN RAMON	1
SAN JUAN	GUAYABAL (CARACOL)	3
SAN JUAN	LA URCA	1
SAN JUAN	TRES MANGA	9
SAN JUAN	HATO NUEVO	4
SAN JUAN	COLUMNA	1
SAN JUAN	HABANERO	5
SAN JUAN	EL LLANITO	1
SAN JUAN	NICARAGUA	2
SAN JUAN	TIERRA DURA	3
SAN JUAN	CARRERA DE NARANJO	1
SAN JUAN	CRUCE DE PEDRO SANCHEZ	1
SAN JUAN	KM. 15 (DESPUES S. JUAN)	1
SAN JUAN	LAS MAYITAS	1
SAN JUAN	HATO VIEJO	1
BOHECHIO	LOS NARANJOS	3
BOHECHIO	EL PALMAR	2
BOHECHIO	LA VEREDA	1

MUNICIPALITY	COMMUNITY	# OF PUMPS INSTALLED
BOHECHIO	ARROYO CANO	5
BOHECHIO	LOMA DEL YAQUE	5
BOHECHIO	EL COCO	3
BOHECHIO	BUENA VISTA	9
JUAN DE HERRERA	EL HOYO DE SOSA	5
JUAN DE HERRERA	SABANA DE SOSA	5
JUAN DE HERRERA	PIEDRA BLANCA	3
JUAN DE HERRERA	LAS CARRERAS DE SOSA	4
JUAN DE HERRERA	BUENA VISTA	4
JUAN DE HERRERA	DORMIDERO	9
JUAN DE HERRERA	LOS MONTONES	10
JUAN DE HERRERA	LOMA VERDE	6
JUAN DE HERRERA	MATA RATON	3
JUAN DE HERRERA	JINOVA ABAJC	3
JUAN DE HERRERA	PASA TIEMPO	3
LAS MATAS DE FARFAN	CARRERA DE CEIBA	2
LAS MATAS DE FARFAN	HATO ROSARIO	1
LAS MATAS DE FARFAN	PAJONAL	8
LAS MATAS DE FARFAN	LOS DERRAMADEROS	4
LAS MATAS DE FARFAN	CARRERA DE LIMON	4
LAS MATAS DE FARFAN	PAN DE AZUCAR	8
LAS MATAS DE FARFAN	SEVERINO	6
LAS MATAS DE FARFAN	LA CHINA	3
LAS MATAS DE FARFAN	CANADA HONDA	4
LAS MATAS DE FARFAN	EL RODEO	1
LAS MATAS DE FARFAN	LOS COROCITOS	4
LAS MATAS DE FARFAN	TRES MANGAS	1
LAS MATAS DE FARFAN	SABANA TUNA	8
LAS MATAS DE FARFAN	LA ENEA	5
LAS MATAS DE FARFAN	EL PANDO	5
LAS MATAS DE FARFAN	ISABELICA	3
LAS MATAS DE FARFAN	PALO AMARGO	1
LAS MATAS DE FARFAN	CAMPOCHE	1
LAS MATAS DE FARFAN	COMEDERO VALLO	4
LAS MATAS DE FARFAN	LOS CORRALES	2
LAS MATAS DE FARFAN	PIEDRA DE AMOLAR	1
LAS MATAS DE FARFAN	SABANA SIERRA	2
LAS MATAS DE FARFAN	CARRERA DE BURRO	1
LAS MATAS DE FARFAN	CABEZA DE BESTIA	1
LAS MATAS DE FARFAN	EL VALLECITO	1
LAS MATAS DE FARFAN	EL GUAYACAN	3
LAS MATAS DE FARFAN	LOS FUNDOS VIEJOS	2
LAS MATAS DE FARFAN	LA SIERRA	2
LAS MATAS DE FARFAN	LAS MULAS	7

SESPAS

HEALTH SECTOR II
NUMBER OF HAND PUMPS INSTALLED BY COMMUNITY
ELIAS PINA UNIT
JANUARY 1984

MUNICIPALITY	COMMUNITY	# OF PUMPS INSTALLED
TOTAL......		291
COMENDADOR	RANCHO EL NEGRO	1
COMENDADOR	LA CUNA	1
COMENDADOR	LOS CORBANOS	1
COMENDADOR	EL JUNQUITO	2
COMENDADOR	ANGOSTURA	3
COMENDADOR	HATO VIEJO	5
COMENDADOR	CANDELON	2
COMENDADOR	CANADA GRANDE	2
COMENDADOR	SABANA LARGA	3
COMENDADOR	SABANETA	3
COMENDADOR	LOS CERROS	3
COMENDADOR	ESCONDIDO	1
COMENDADOR	GUAZUMAL	4
COMENDADOR	GUAYABO ARRIBA	2
COMENDADOR	GUAYABO AL MEDIO	2
COMENDADOR	GUAYABO ABAJO	2
COMENDADOR	ISIDRO MARTINEZ	2
COMENDADOR	LA MESETA DE GUAYABO	3
COMENDADOR	FONDO DE GUAYABO	2
BANICA	LOMA FIRME	2
BANICA	HIGUERITO	1
BANICA	BRITO	1
BANICA	EL CANTON	2
BANICA	HATO VIEJO	5
BANICA	LOS BOQUERONES	3
BANICA	SABANA EN MEDIO	1
BANICA	LA LAJITA	2
BANICA	ARROYO SALADO	3
BANICA	BLAS MARTINEZ	4
EL LLANO	PALO SECO	1
EL LLANO	BENANCIO	8
EL LLANO	LOS ARROYOS	6
EL LLANO	GUANITO	11
EL LLANO	LA LAJITA	9
EL LLANO	REBOZO	3
LAS MATAS DE FARFAN	MIGUEL MARTINEZ	2
LAS MATAS DE FARFAN	LOS JOBOS	12
LAS MATAS DE FARFAN	LAS CARRERAS	2
LAS MATAS DE FARFAN	LA HOYA	1
LAS MATAS DE FARFAN	LOS CIMARRONES	3

MUNICIPALITY	COMMUNITY	# OF PUMPS INSTALLED
LAS MATAS DE FARFAN	LA JAGUITA	4
LAS MATAS DE FARFAN	CARRERA DE MARCOS	2
LAS MATAS DE FARFAN	COCINERA	5
LAS MATAS DE FARFAN	BARRERITO	5
LAS MATAS DE FARFAN	GUARAGUAO	3
LAS MATAS DE FARFAN	LA VIGIA	3
LAS MATAS DE FARFAN	MATAYAYA	2
LAS MATAS DE FARFAN	LOS ABEJOS	4
LAS MATAS DE FARFAN	LAS PAREDES	2
LAS MATAS DE FARFAN	OLIVERO	6
LAS MATAS DE FARFAN	LOS CALABAZOS	2
LAS MATAS DE FARFAN	LOS CERCADILLOS	3
LAS MATAS DE FARFAN	RIO DEL PADRE	4
LAS MATAS DE FARFAN	LOS HOYOS	2
LAS MATAS DE FARFAN	EL PINO	2
LAS MATAS DE FARFAN	CANA SEGURA	7
LAS MATAS DE FARFAN	MATA DE CAO	6
LAS MATAS DE FARFAN	LA PIEDRA	1
LAS MATAS DE FARFAN	ESCONDIDO	7
LAS MATAS DE FARFAN	BAITOITA	2
LAS MATAS DE FARFAN	EL MANGIL	2
LAS MATAS DE FARFAN	LOS SALADILLOS	5
LAS MATAS DE FARFAN	LA ESTANCIA	4
LAS MATAS DE FARFAN	LA MESETA	2
LAS MATAS DE FARFAN	EL MAMON	7
LAS MATAS DE FARFAN	LA FLOR	6
LAS MATAS DE FARFAN	SAN JOSE	3
LAS MATAS DE FARFAN	LUIS SIMON	1
LAS MATAS DE FARFAN	LA POCILGA	6
LAS MATAS DE FARFAN	PESO FUERTE	1
LAS MATAS DE FARFAN	AGRIO DULCE	1
LAS MATAS DE FARFAN	LOS MOLINOS	3
EL CERCADO	SABANA DE LA RANCHA	2
EL CERCADO	EL PALMAR DE LA RANCHA	5
EL CERCADO	EL CAPACITO	5
EL CERCADO	EL MAJAGUAL	4
EL CERCADO	LA JAGUITA	5
EL CERCADO	LOS MEMISOS	2
EL CERCADO	LA MONTEADITA	6
EL CERCADO	RANCHO VIEJO	2
EL CERCADO	CUERO DE PUERCO	2
EL CERCADO	LA MESETA	1
EL CERCADO	EL GUANAL	5
EL CERCADO	LA GUAMA	11
EL CERCADO	LA MULATA	1
EL CERCADO	PUERTECITO	1

SESPAS

HEALTH SECTOR II
NUMBER OF HAND PUMPS INSTALLED BY COMMUNITY
SANTIAGO RODRIGUEZ UNIT
JANUARY 1984

MUNICIPALITY	COMMUNITY	# OF PUMPS INSTALLED
TOTAL.........		57
DAJABON	SABANA LARGA	3
DAJABON	LA GORRA	9
DAJABON	ESPERON	3
DAJABON	LOS INDIOS	2
DAJABON	LOS MESONES	2
DAJABON	SABANA SANTIAGO	1
DAJABON	JACUBA	2
DAJABON	CAYUCO	5
DAJABON	CANDELON	3
DAJABON	CHACUEY	6
DAJABON	PASO TAPAO	3
DAJABON	TAWIKE	1
LOMA DE CABRERA	PIEDRA BLANCA	2
LOMA DE CABRERA	PIEDRA BLANCA AL MEDIO	2
LOMA DE CABRERA	CAMPECHE	5
LOMA DE CABRERA	LA HOYA	4
PARTIDO	BUEN GUSTO	2
PARTIDO	SANGRE LINDA	2

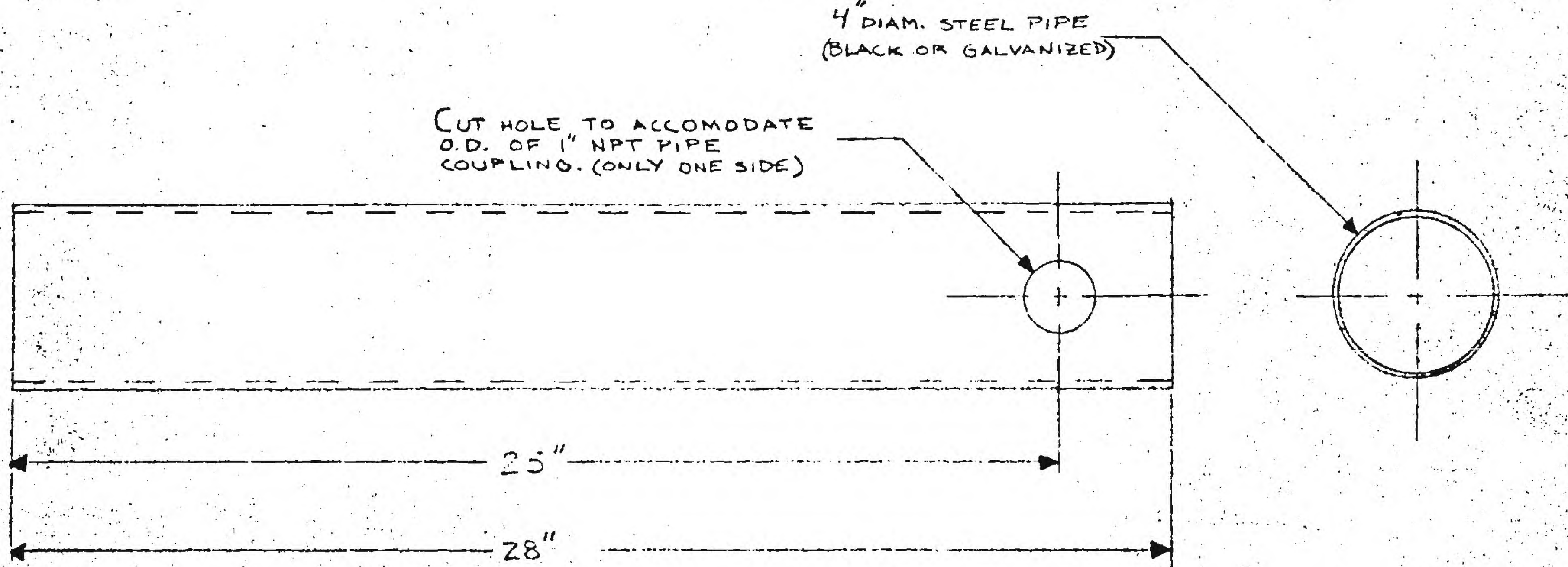
APPENDIX B

STEEL HAND PUMP AND TRIPOD DESIGN DRAWINGS

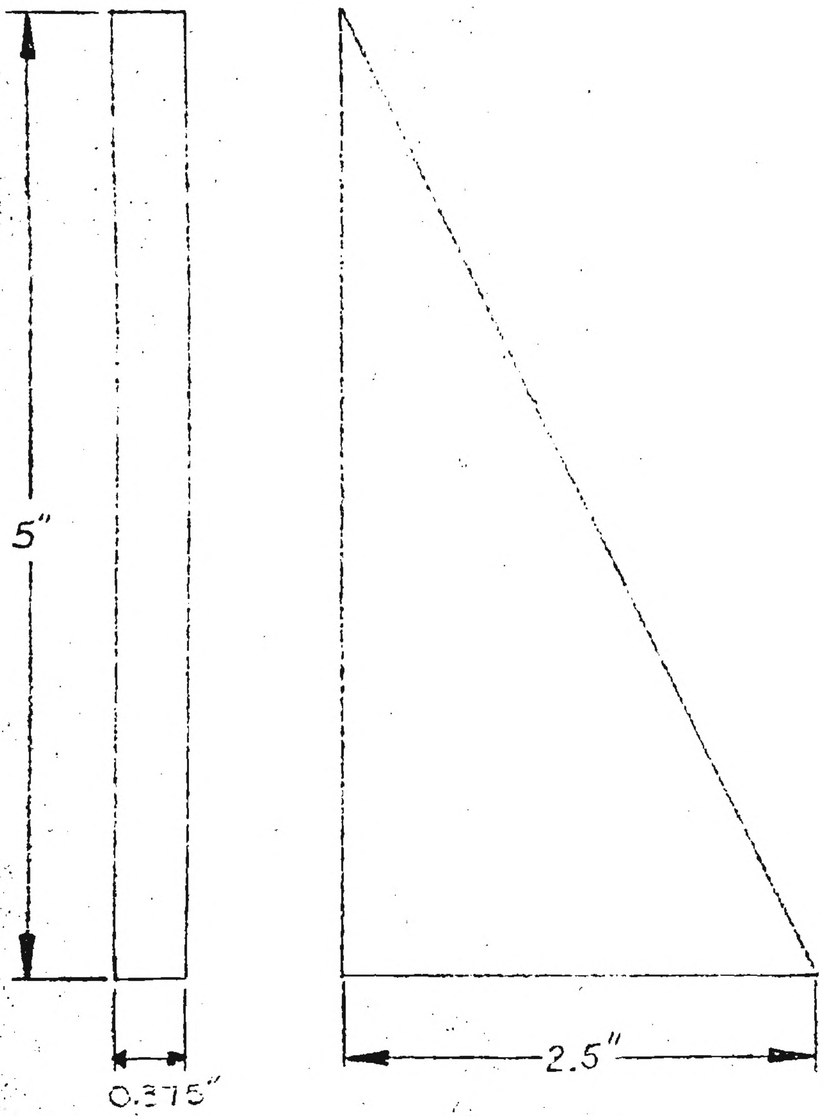
DRAWING LIST

Number	Name
1	Boby Pipe
2	Gusset
3	Base Plate
4	Body and Cap Joint Plate
5	Cap Pipe
6	Cap Top
7	Bearing Plate
8	Bearing Cover Plate
9	Horizontal Box Guard
10	Vertical Box Guard
11	Assembly and Welding of Box Guard Components
12	Gland Plate
13	Gland Body
14	Gland Nut
15	Handle Tube
16	Chain Sector
17	Lower Arc Support
18	Upper Arc Support
19	Handle-Chain Coupling
20	Axle Shaft
21	Chain - Rod Coupling
22	Gaskets
23	Piston Components
24	Leather Cup and Rubber Washer
25	Cylinder and Piston Assembly

Number	Name
26	Body Assembly
27	Cap Assembly
28	Handle Assembly
29	Pump Assembly
30	Fixture for Box
31	Fixture for Box
32	Tripod Components
33	Tripod Assembly



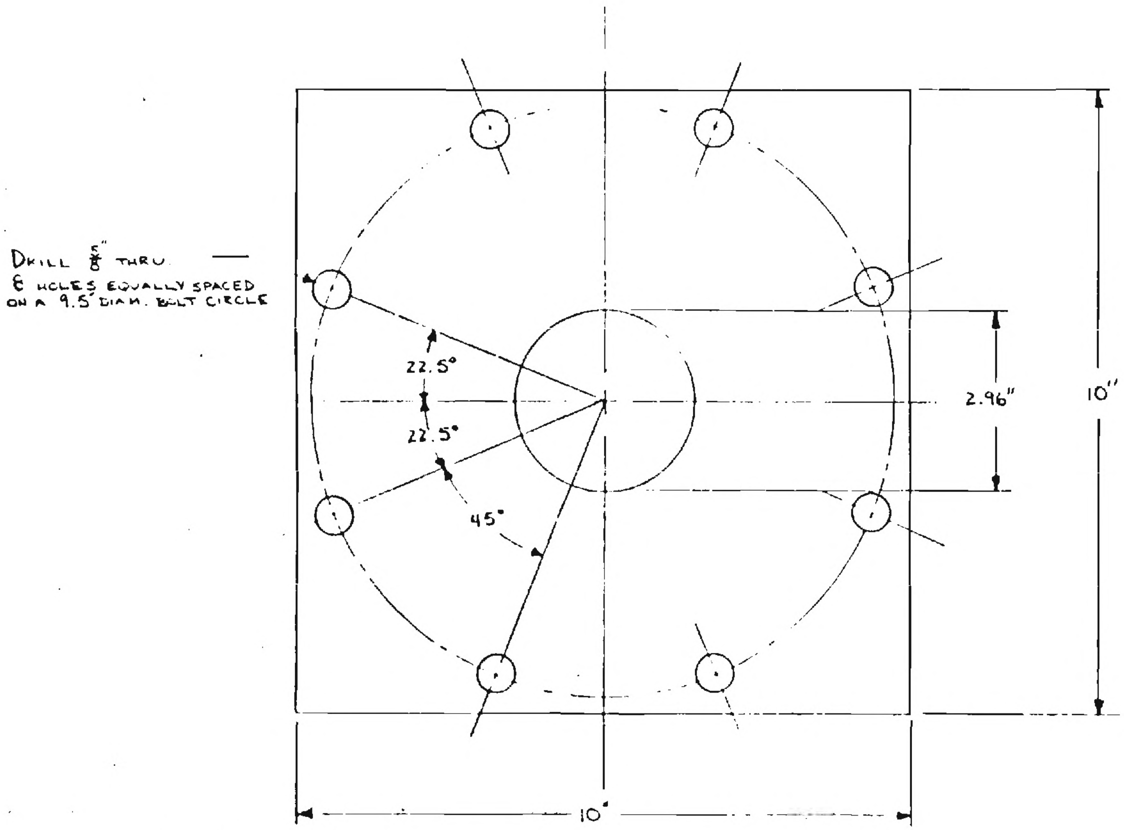
BODY PIPE		
SCALE: 1"=4"	APPROVED BY:	DRAWN BY
DATE: 2-9-84		REVISED
QTY: 1 PER PUMP		
		DRAWING NUMBER GT-1



GUSSET

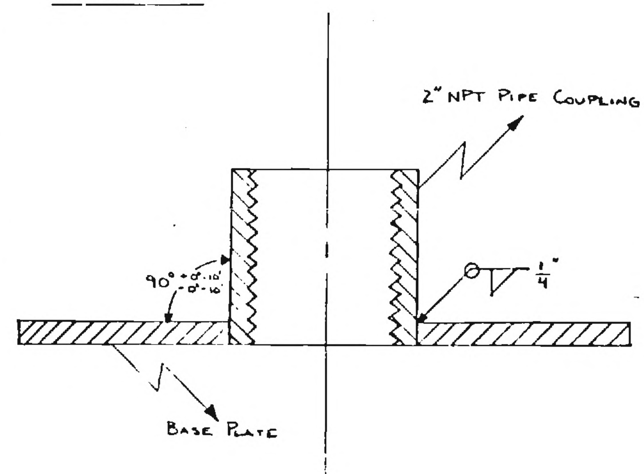
SCALE: 1"=1"	APPROVED BY:	DRAWN BY
DATE: 2-9-84		REVISED

QTY: 4 PER PUMP



NOTES:
① CENTER HOLE TO BE CUT TO ACCOMODATE O.D. OF A STANDARD 2" NPT PIPE COUPLING.
② AFTER WELDING, COUPLING TO BE WATER TIGHT, PERPENDICULAR TO BASE AND FLUSH WITH BOTTOM SURFACE OF BASE.

ASSEMBLY:



BASE PLATE

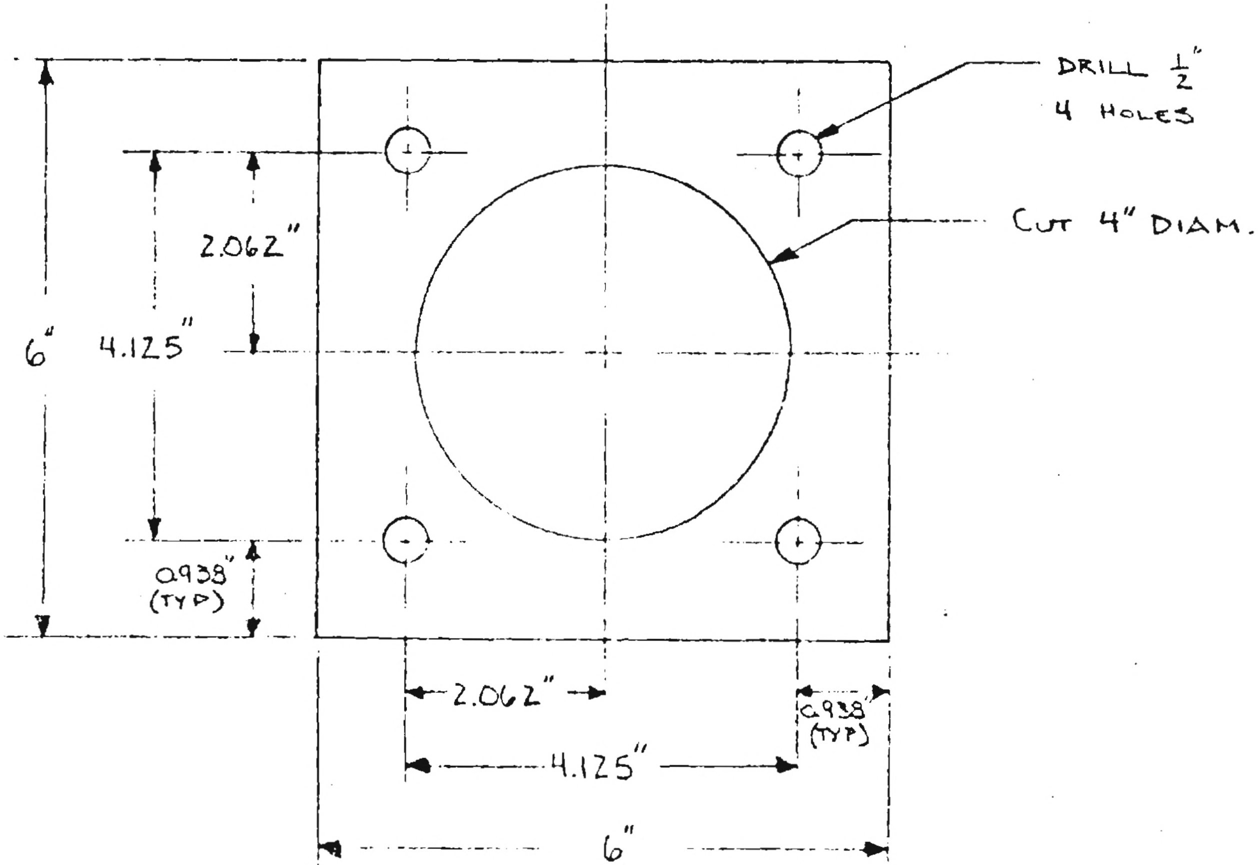
SCALE: 1" = 2"
DATE: 3-8-84
APPROVED BY
DRAWN BY

QTY: 1 PER PUMP

MATERIAL: MILD STEEL 3/8" THICK

DRAWING NUMBER GT-3

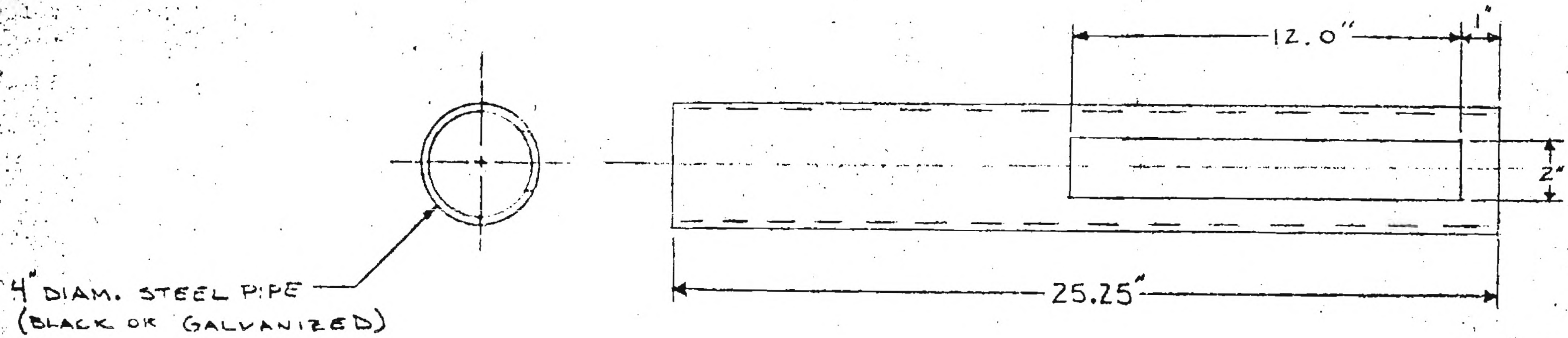
NO. 1884-11X17



BODY AND CAP JOINT PLATES

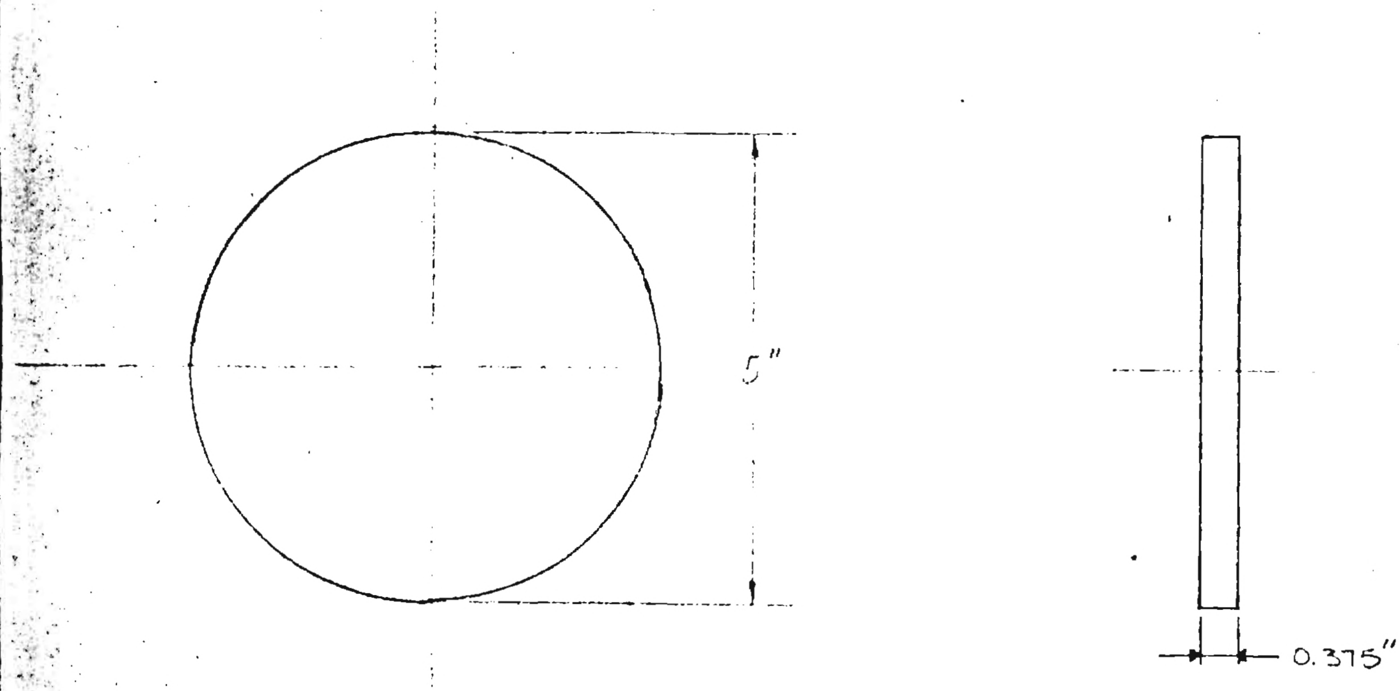
SCALE: 1" = 2"	APPROVED BY:	DRAWN BY
DATE: 3-10-84		REVISED

QTY: 2 PER PUMP.

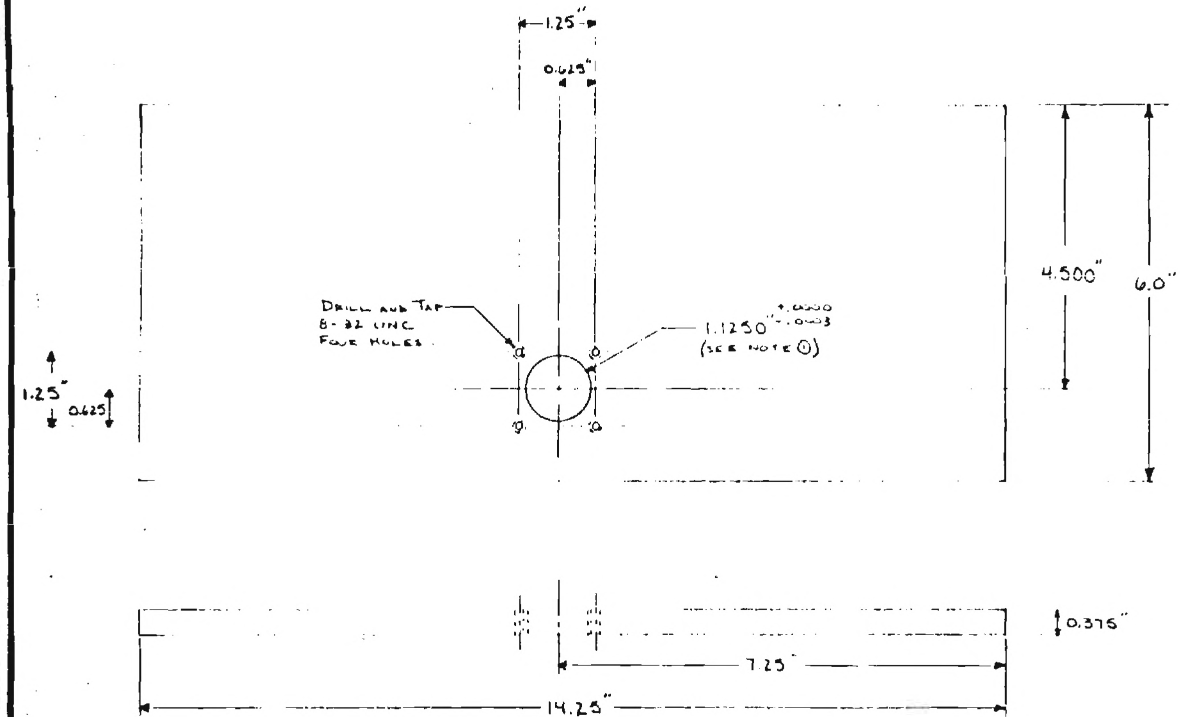


NOTE: CUT 11.75" x 2" SLOT IN PIPE ON ONE SIDE AS SHOWN.

CAP PIPE		
SCALE: 1" = 5"	APPROVED BY:	DRAWN BY
DATE: 2-9-84		REVISED
QTY: 1 PER PUMP.		
		DRAWING NUMBER GT-5

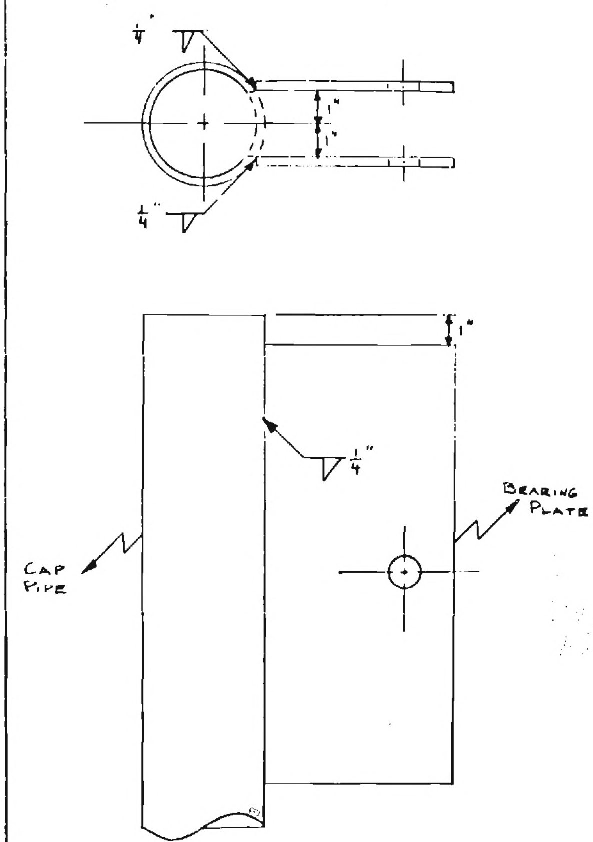


CAP TOP		
SCALE: 1" = 2"	APPROVED BY:	DRAWN BY
DATE: 2-9-84		REVISED
QTY: 1 PER PUMP.		



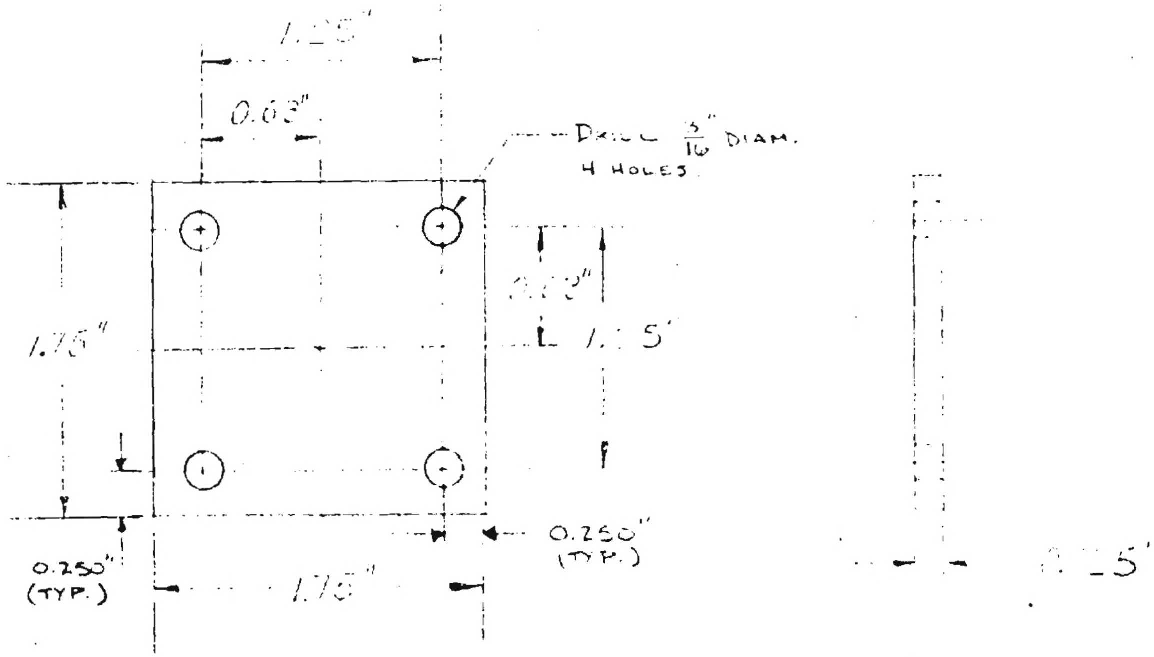
NOTES:
① HOLE WILL BE CUT AS SHOWN OR TO ACCOMODATE AVAILABLE BEARING SIZE WITH A SNUG FIT.
② BEARING HOLES IN THE TWO PLATES AFTER ASSEMBLY MUST BE COAXIAL.

BEARING PLATE TO PUMP CAP
ASSEMBLY DETAILS



BEARING PLATE		
SCALE: 1" = 2"	APPROVED BY	DRAWN BY
DATE: 3-10-84		
QTY: 2 PER PUMP		
MATERIAL: MILD STEEL PLATE 3/8" THICK		DRAWING NUMBER GT-7

NO. 105A-11X17

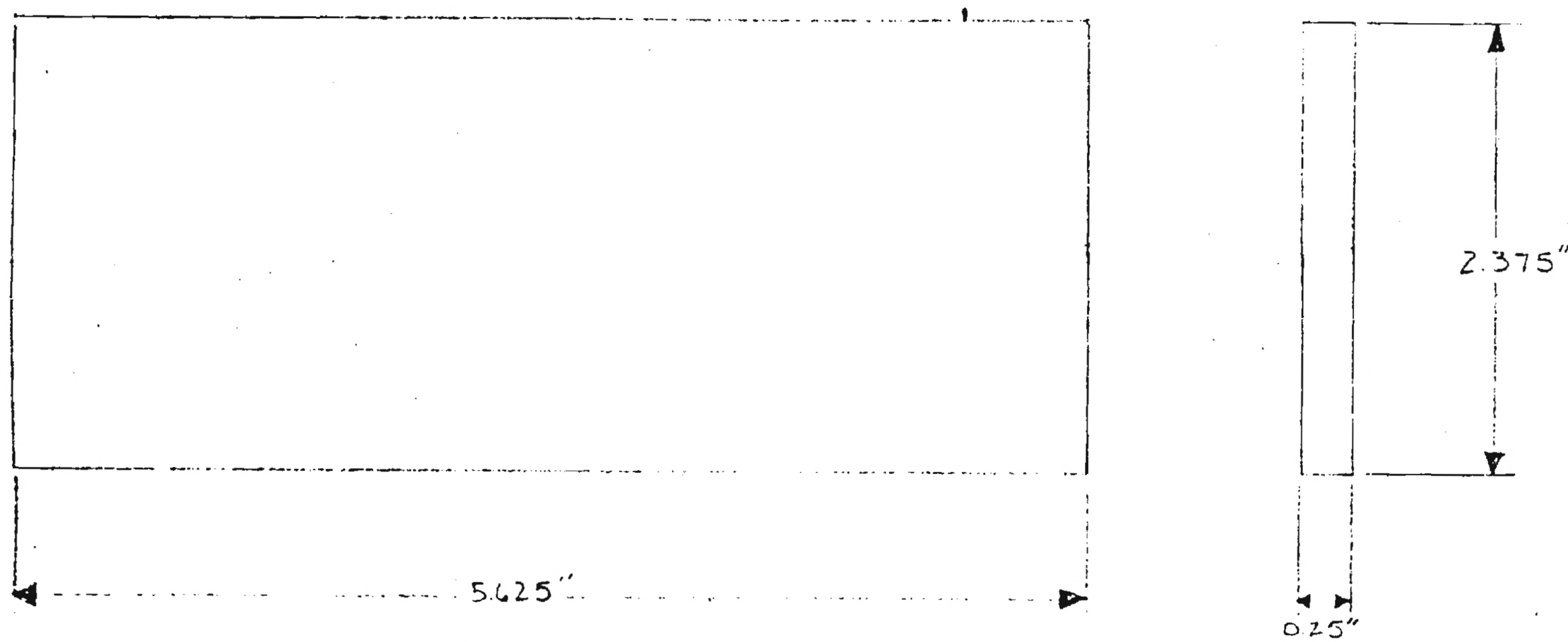


NOTE: ① DRILLED HOLES MUST COINCIDE WITH BOX PLATE HOLES.

BEARING COVER PLATES

SCALE: 1" = 1"	APPROVED BY:	DRAWN BY
DATE: 3-8-84		REVISED

QTY.: 2 PER PUMP.

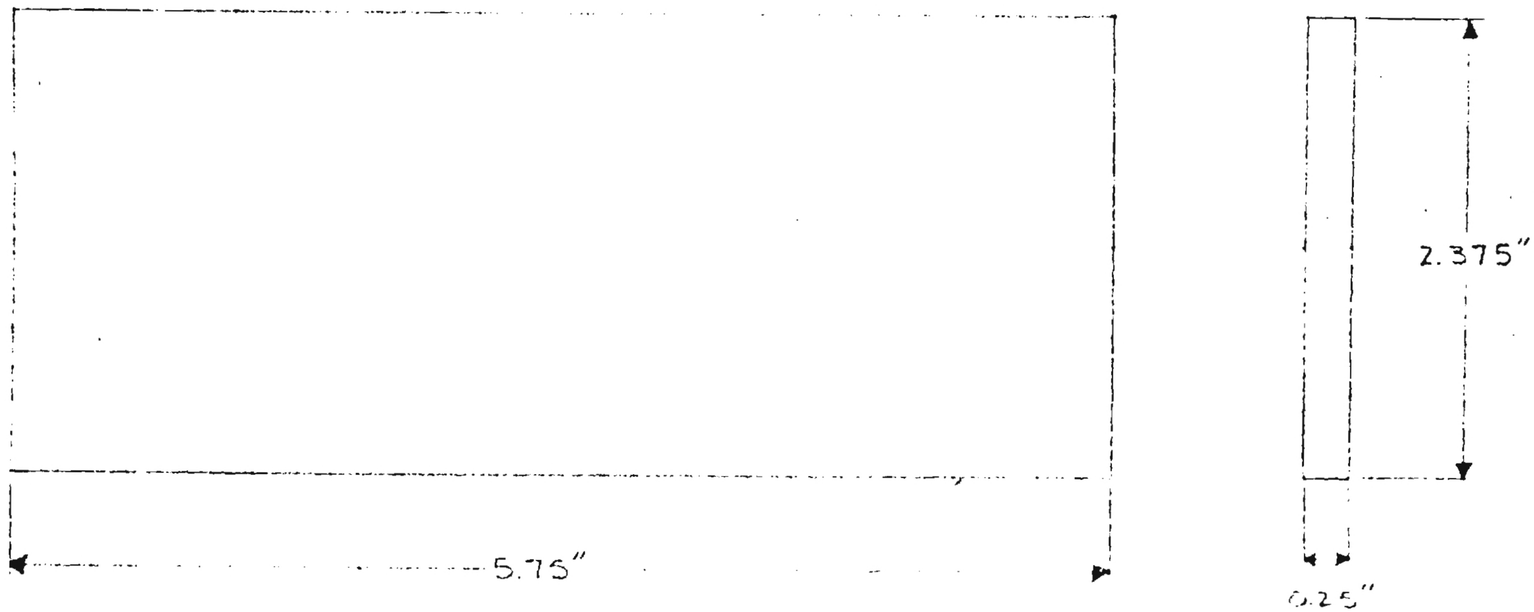


HORIZONTAL BOX GUARD

SCALE: 1" = 1"	APPROVED BY:	DRAWN BY
DATE: 3 - 9 - 84		REVISED

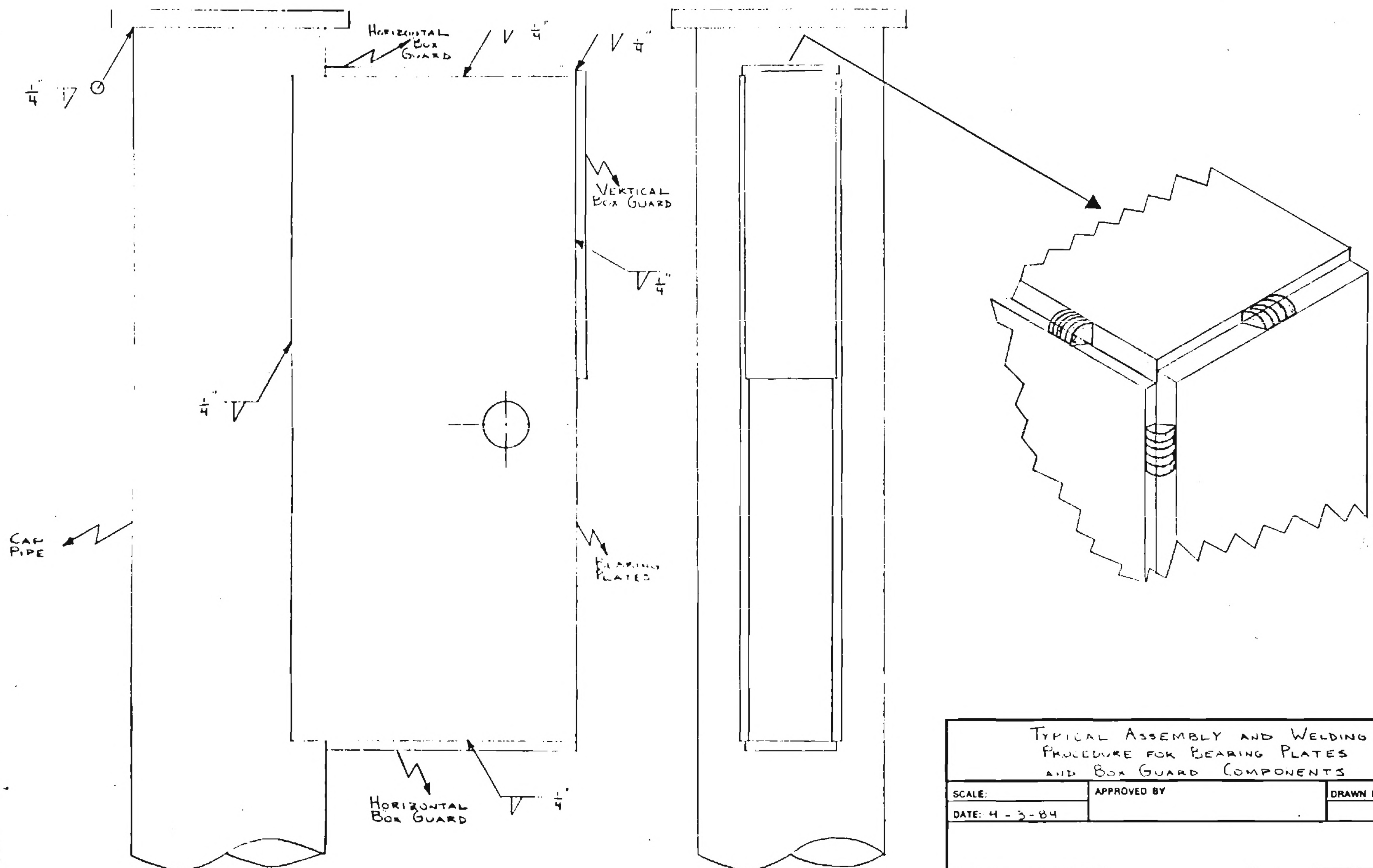
QTY: 2 PER PUMP.

MATERIAL: MILD STEEL PLATE $\frac{1}{4}$" THICK.	DRAWING NUMBER GT - 9



VERTICAL BOX GUARD		
SCALE: 1" = 1"	APPROVED BY:	DRAWN BY
DATE: 3-11-84		REVISED

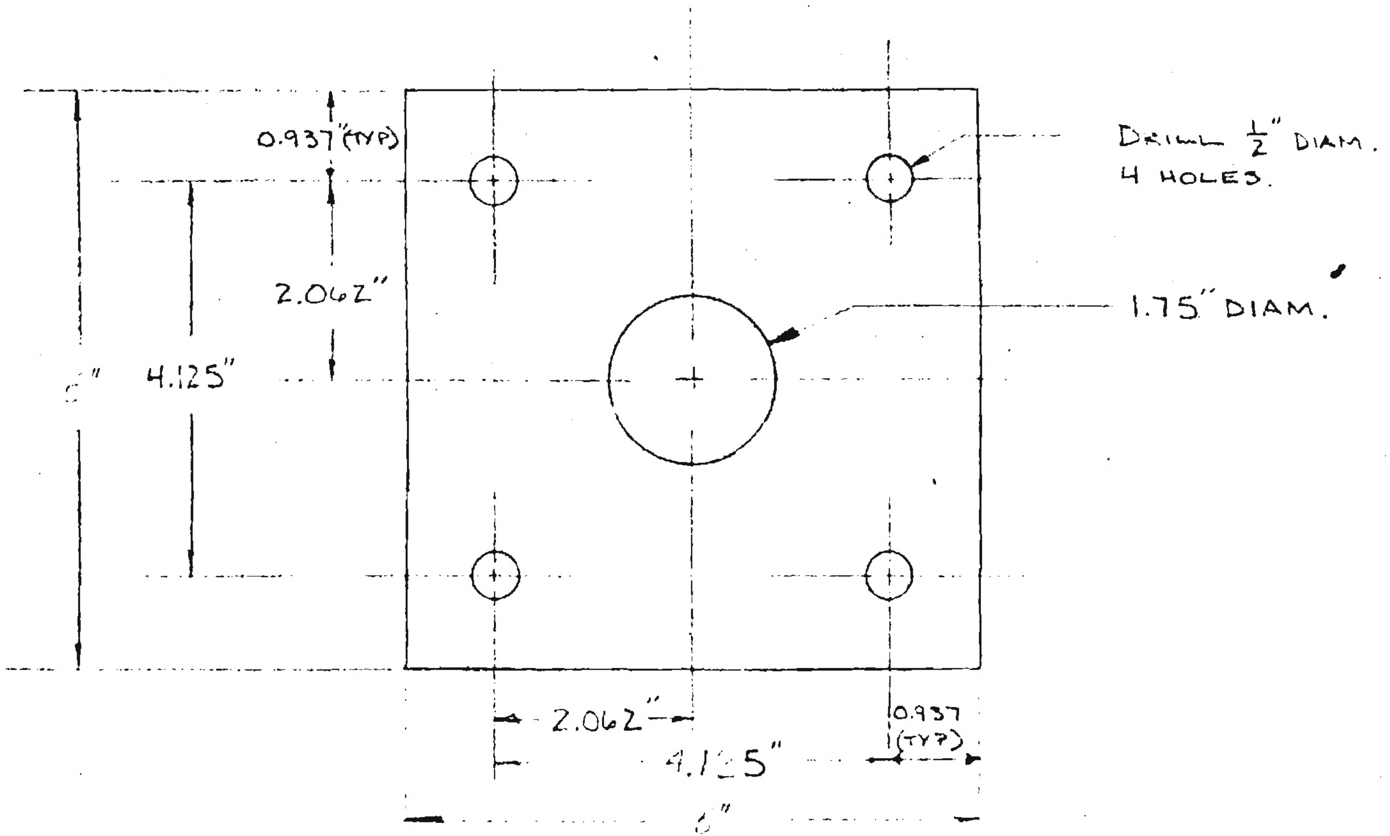
VERTICAL BOX GUARD: QTY: 1 PER PUMP



Typical Assembly and Welding Procedure for Bearing Plates and Box Guard Components

SCALE:	APPROVED BY	DRAWN BY
DATE: 4-3-84		
		DRAWING NUMBER GT-11

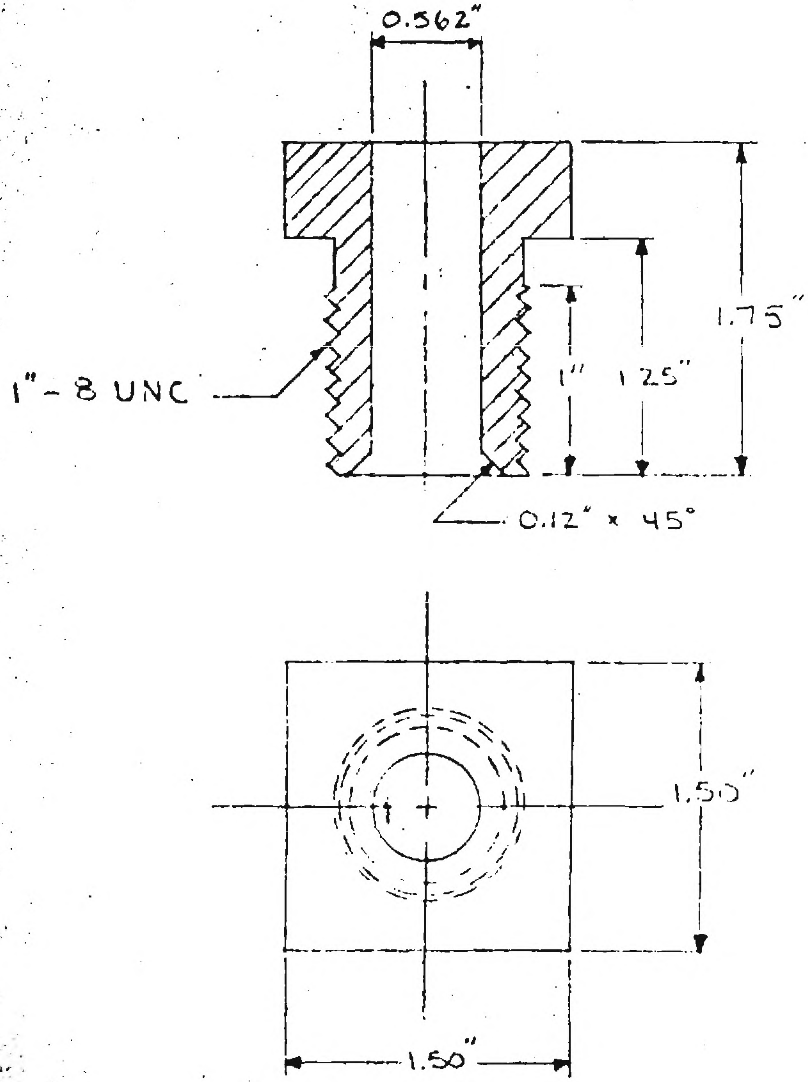
NO. 1664-11X17



GLAND PLATE

SCALE: 1" = 2"	APPROVED BY:	DRAWN BY
DATE: 3-10-84		REVISED

QTY: 1 PER PUMP



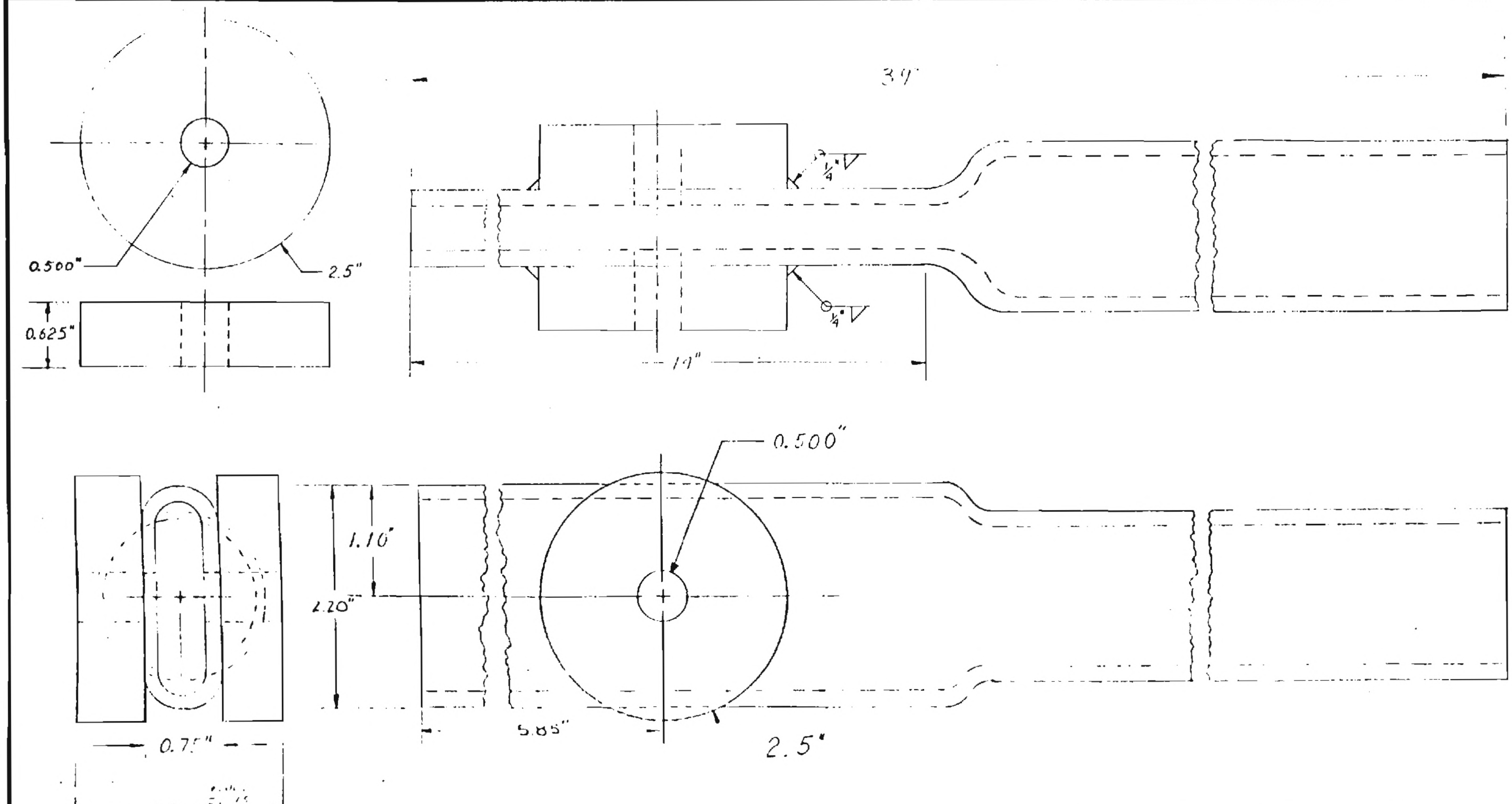
GLAND NUT

SCALE: 1" = 1"	APPROVED BY:	DRAWN BY
DATE: 2-8-84		REVISED

QTY: 1 PER PUMP

MATERIAL: STEEL BAR $1\frac{1}{2}$" x $1\frac{1}{2}$"

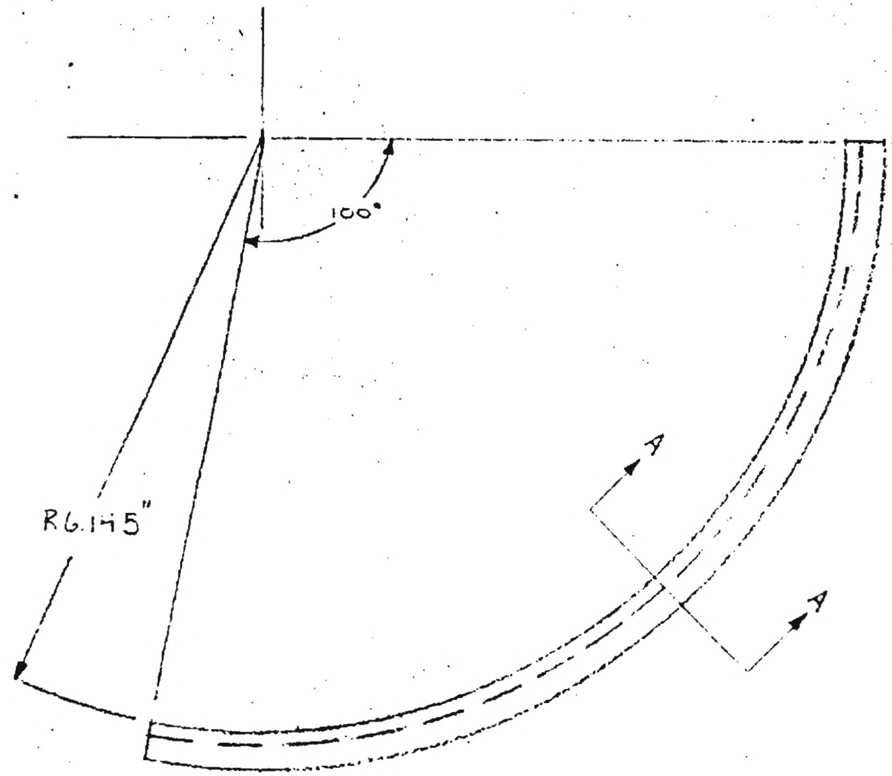
DRAWING NUMBER GT-14



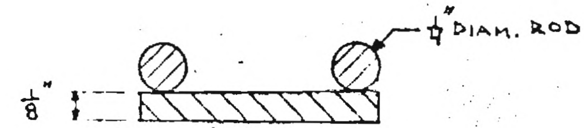
NOTES: ① HEAT PIPE BEFORE [illegible]
② WELD SPACERS TO HANDLE AS SHOWN AND DRILL A 0.50" HOLE THRU.

HANDLE TUBE		
SCALE: 1" = 1"	APPROVED BY	DRAWN BY
DATE: 3-8-84		
QTY:		
		DRAWING NUMBER GT - 15

NOTES:
1. BEND PLATE AND ROD TO SHAPE.
2. TACK WELD ROD TO ENDS AND EVERY 3".



SECTION A-A
(TYPICAL)



SCALE: 1" = 1"

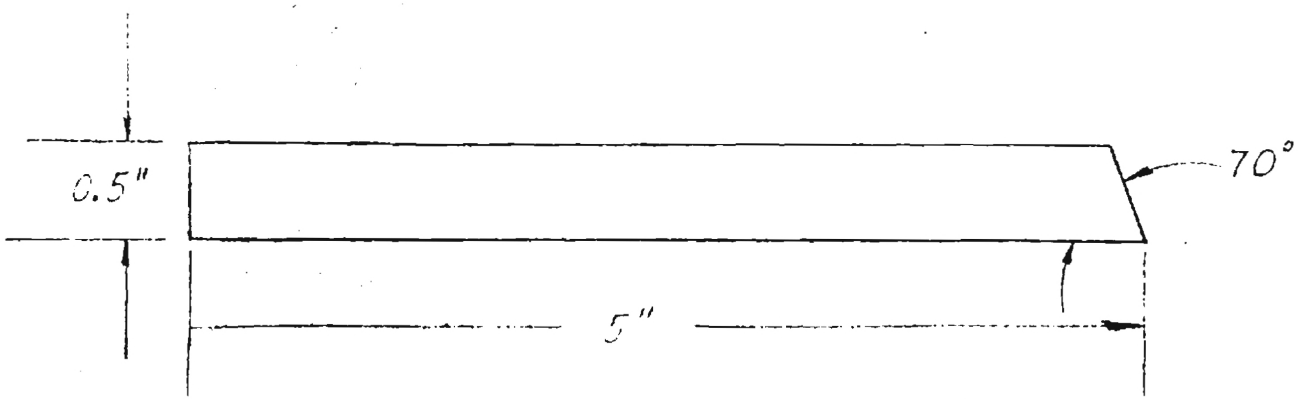
CHAIN SECTOR

SCALE: 1" - 2"
DATE:
APPROVED BY:
DRAWN BY
REVISED

QTY: 1 PER PUMP

MATERIAL: $1\frac{1}{4}$" × $\frac{1}{8}$" STEEL PLATE/$\frac{1}{4}$" DIAM. STEEL ROD

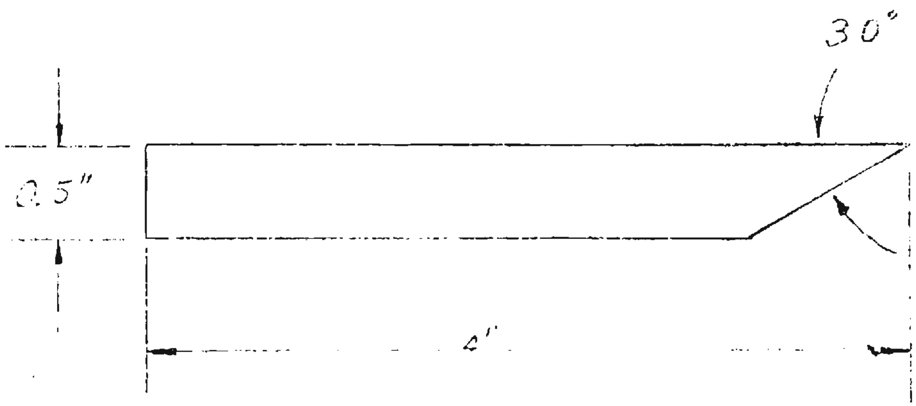
DRAWING NUMBER
GT-16



Lower Arc Support

SCALE: 1" = 1"	APPROVED BY:	DRAWN BY
DATE: 3-7-84		REVISED

QTY: 1 PER PUMP

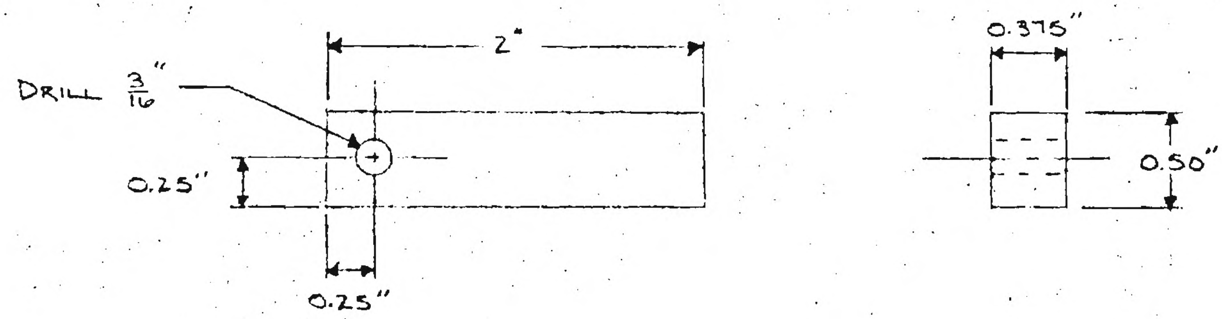


Upper Arc Support

SCALE: 1" = 1	APPROVED BY:	DRAWN BY
DATE: 3-10-84		REVISED

QTY: 1 PER PUMP

MATERIAL: $\frac{1}{2}$" x $\frac{3}{4}$" STEEL BAR	DRAWING NUMBER GT-18

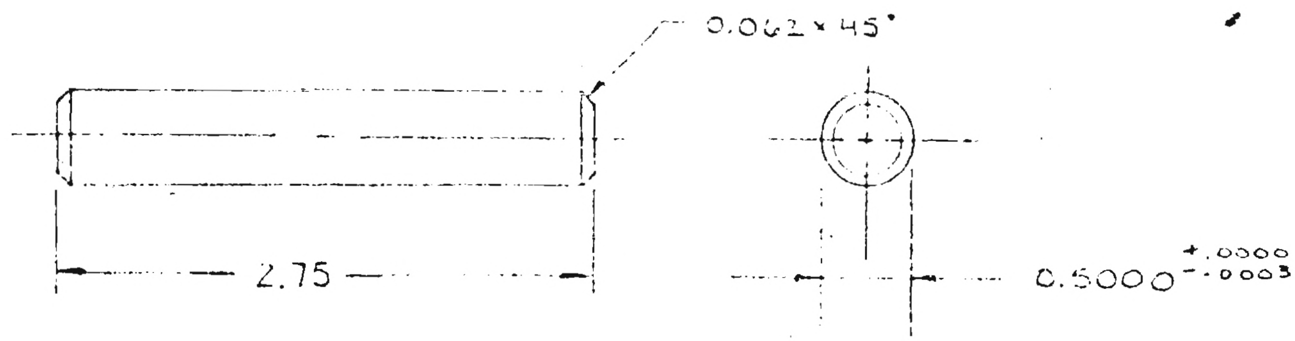


NOTE: WELD TO UPPER ARC SUPPORT TO ALLOW CHAIN TO LIE FLAT ON CHAIN SECTOR.

HANDLE - CHAIN COUPLING

SCALE: 1" = 1"	APPROVED BY:	DRAWN BY
DATE: 3-11-84		REVISED 4-2-84

QTY: 1 PER PUMP



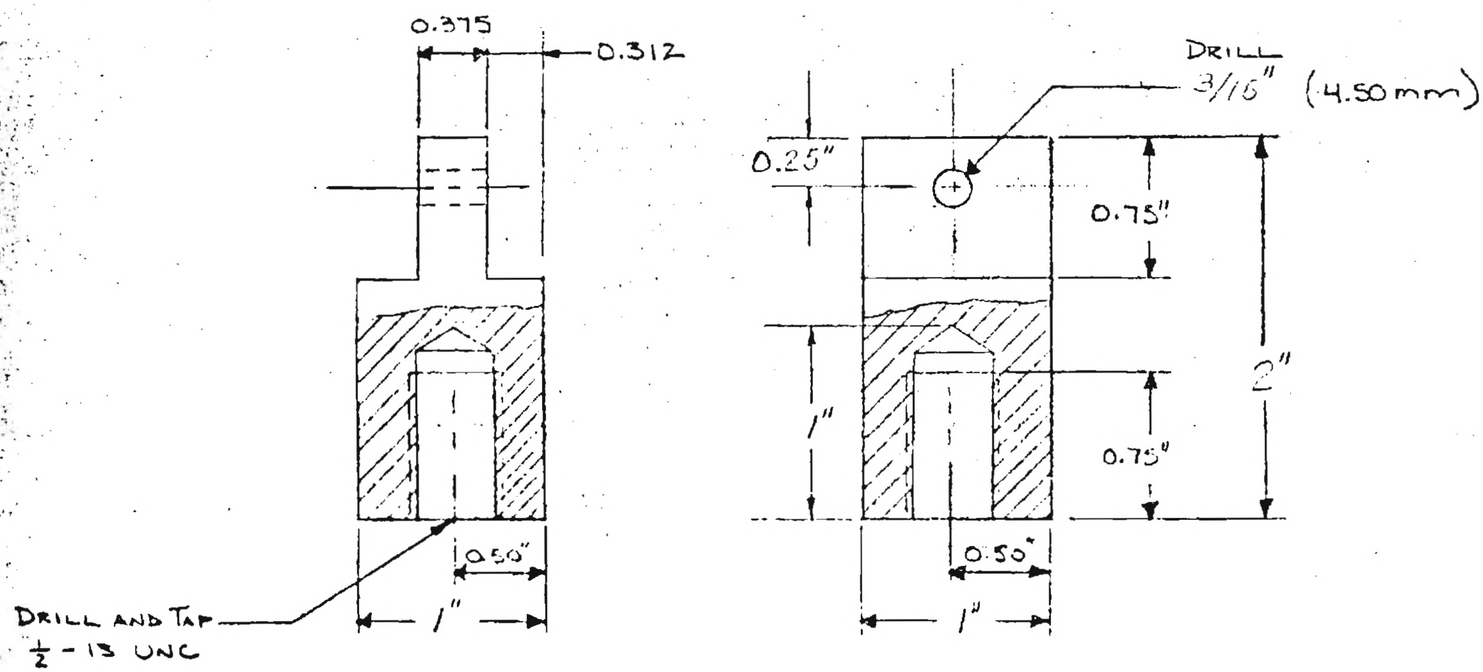
NOTES:

① DIAMETER OF THE AXLE SHAFT WILL VARY ACCORDING TO BEARING SIZE.

② SHAFT TO HAVE A SNUG FIT WITH THE HANDLE AND BEARINGS.

AXLE SHAFT

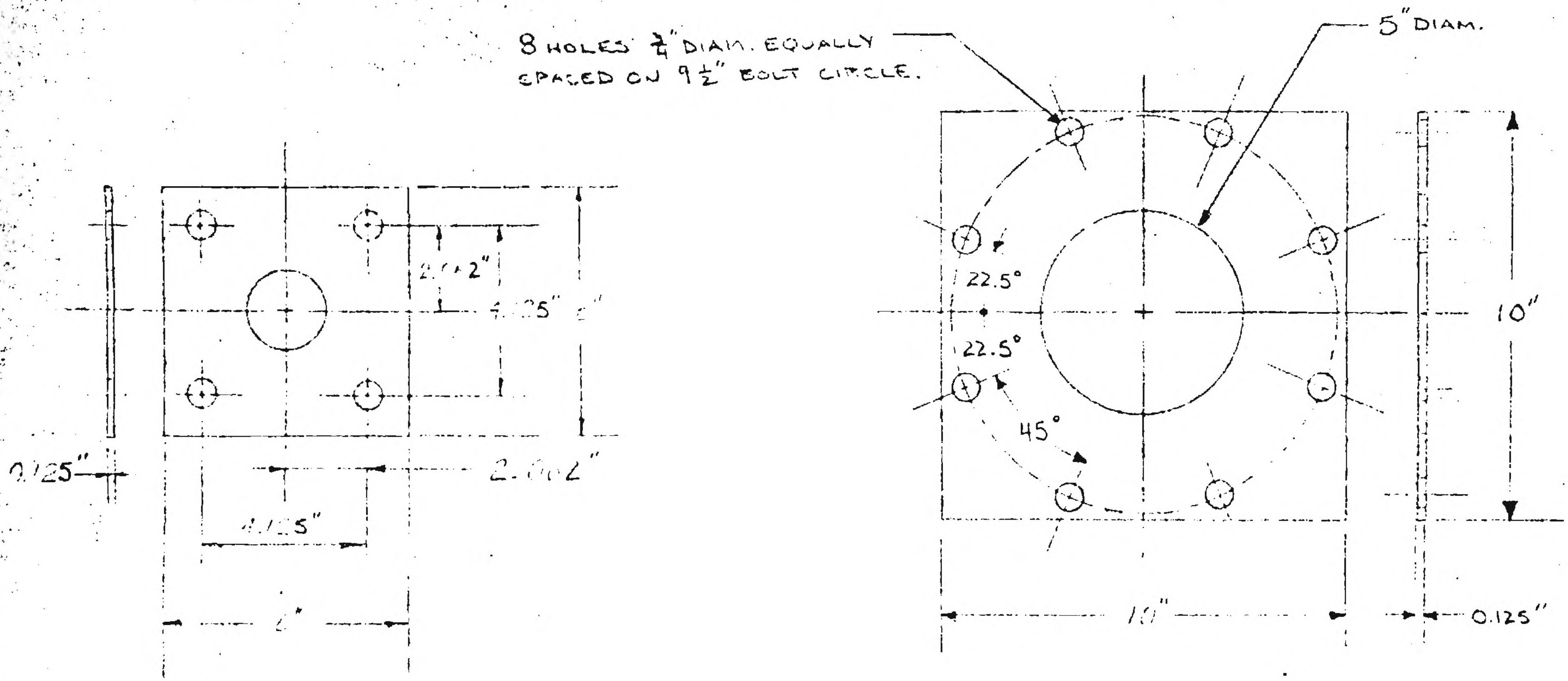
SCALE: 1" = 1"	APPROVED BY:	DRAWN BY
DATE: 3-14-84		REVISED
QTY: 1 PER PUMP		
MATERIALS: $\frac{1}{2}$" DIAM. STEEL ROD		DRAWING NUMBER GT-20



CHAIN-ROD COUPLING

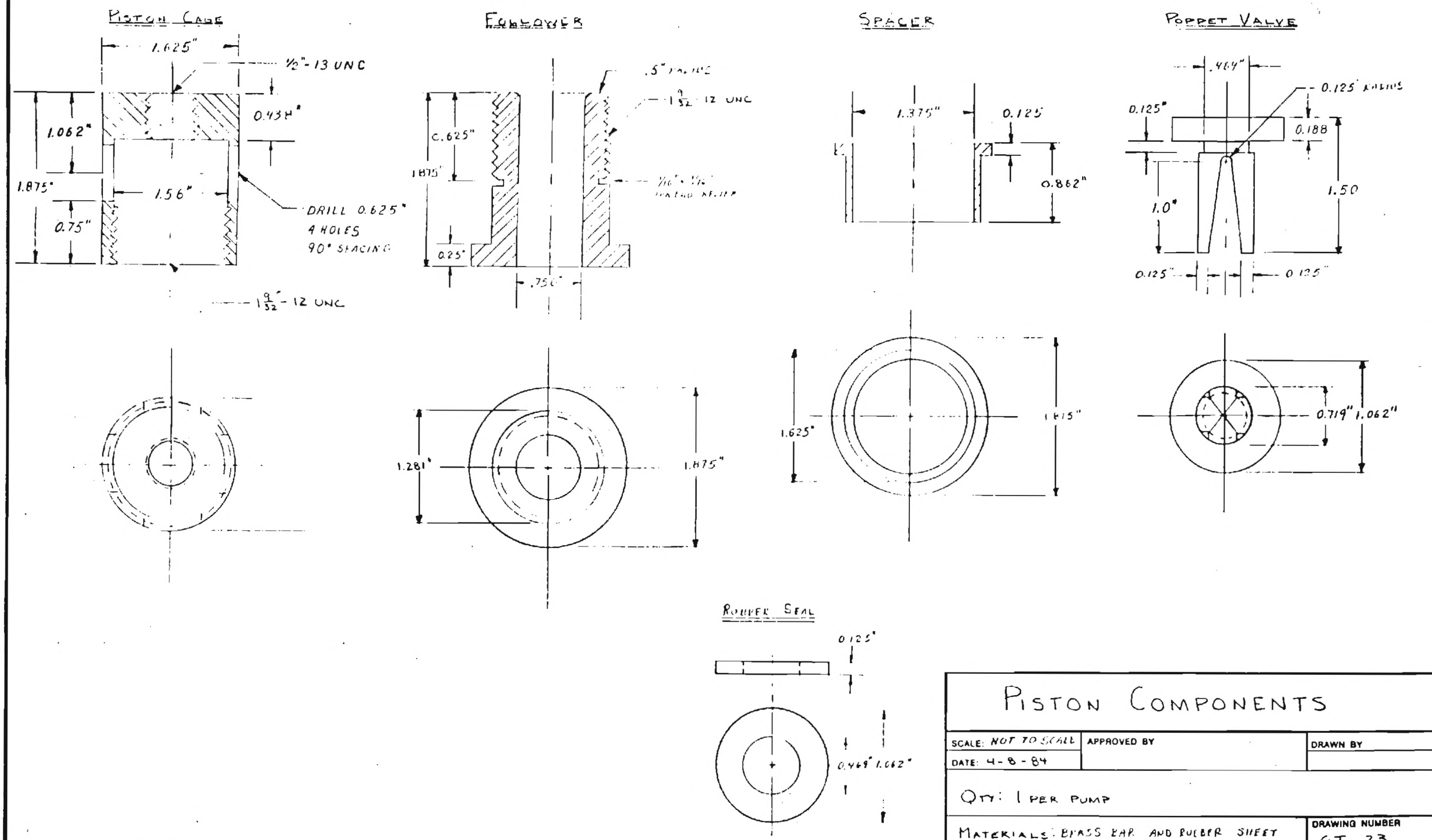
SCALE: 1" = 1"	APPROVED BY:	DRAWN BY
DATE: 3-10-84		REVISED

QTY: 1 PER PUMP



GASKETS

SCALE: 1" = 4"	APPROVED BY:	DRAWN BY
DATE: 3-9-84		REVISED
QTY: 1 OF EACH TYPE PER PUMP		
MATERIALS: 1/8" RUBBER SHEET		DRAWING NUMBER GT-22



PISTON COMPONENTS

SCALE: NOT TO SCALE	APPROVED BY	DRAWN BY
DATE: 4-8-84		

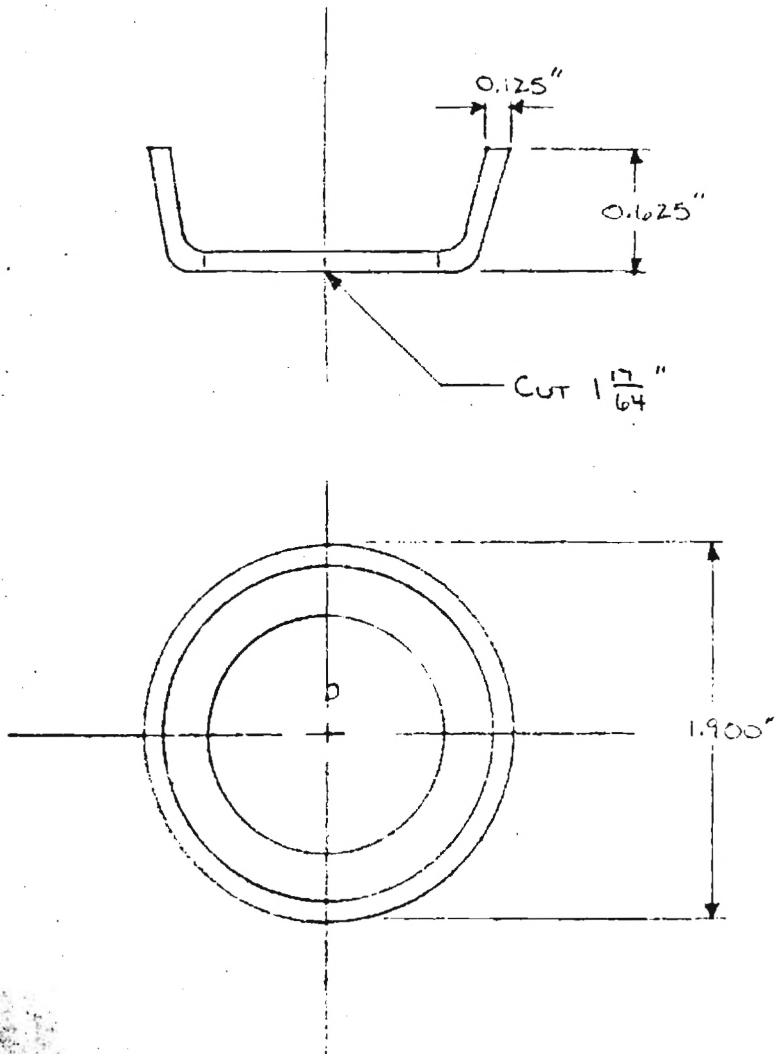
QTY: 1 PER PUMP

MATERIALS: BRASS BAR AND RUBBER SHEET

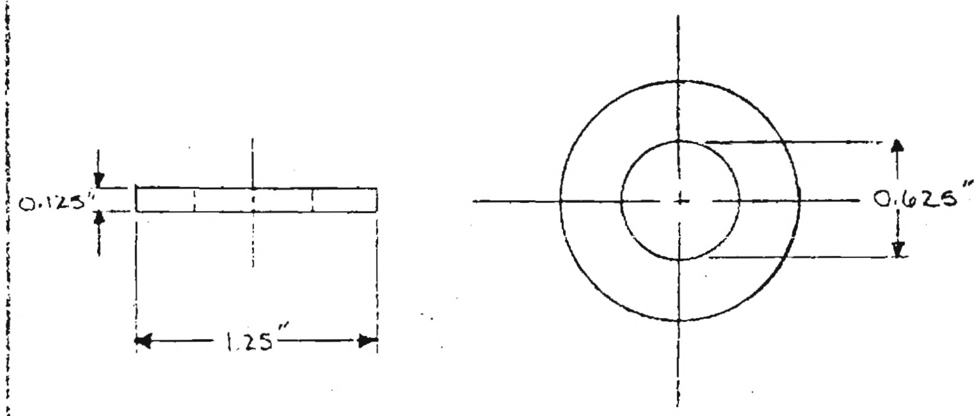
DRAWING NUMBER GT-23

NO. 188A-11X17

LEATHER CUP:

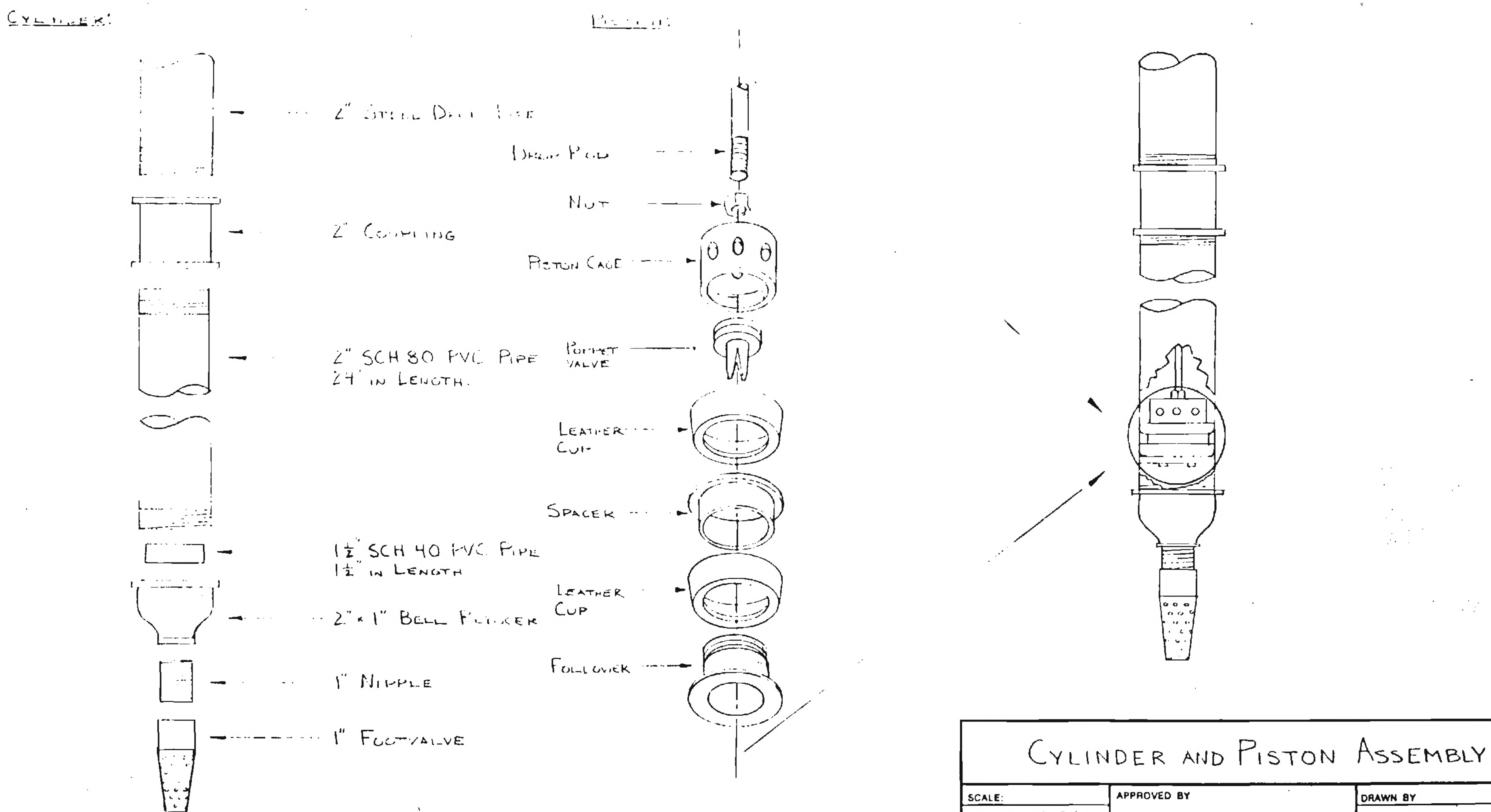


POPPET VALVE RUBBER WASHER:



LEATHER CUP AND RUBBER WASHER

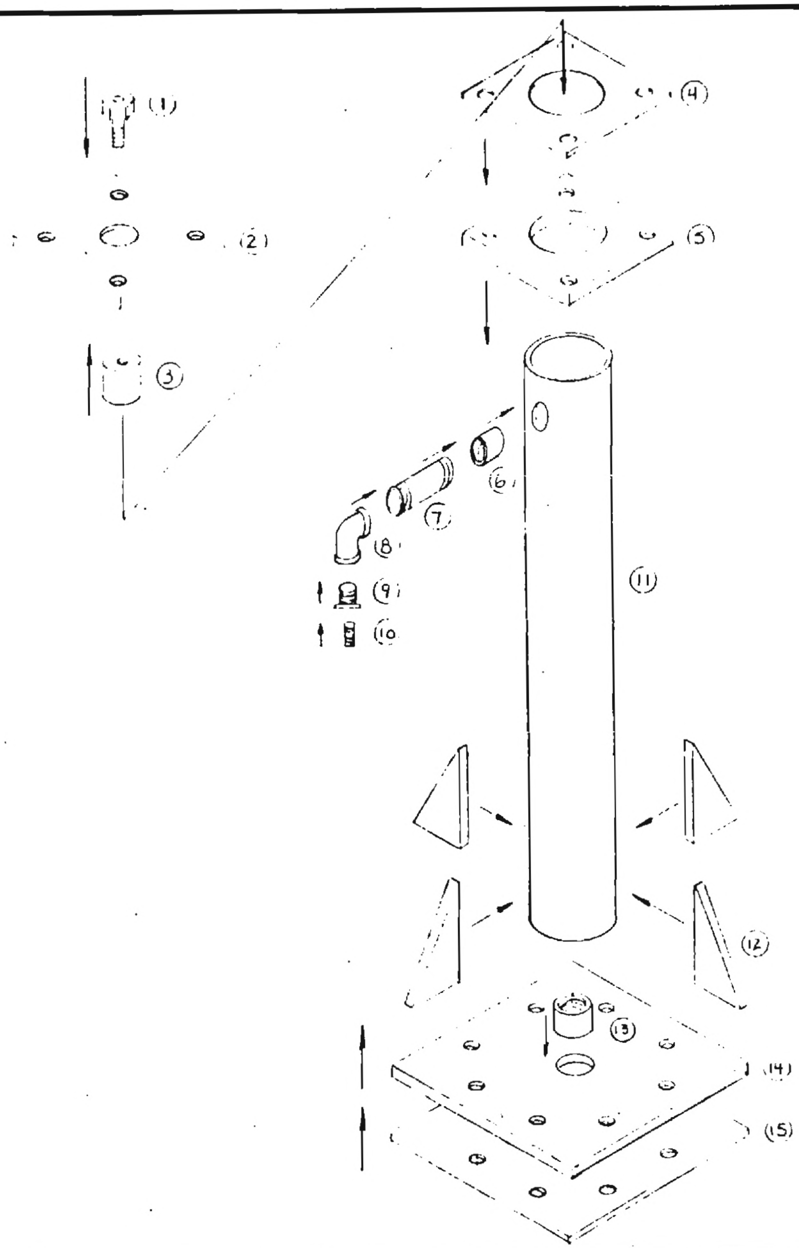
SCALE: 1" = 1"	APPROVED BY:	DRAWN BY
DATE: 3-4-84		REVISED
		DRAWING NUMBER GT-24



Cylinder and Piston Assembly

SCALE:	APPROVED BY	DRAWN BY
DATE: 3-14-84		
		DRAWING NUMBER GT-25

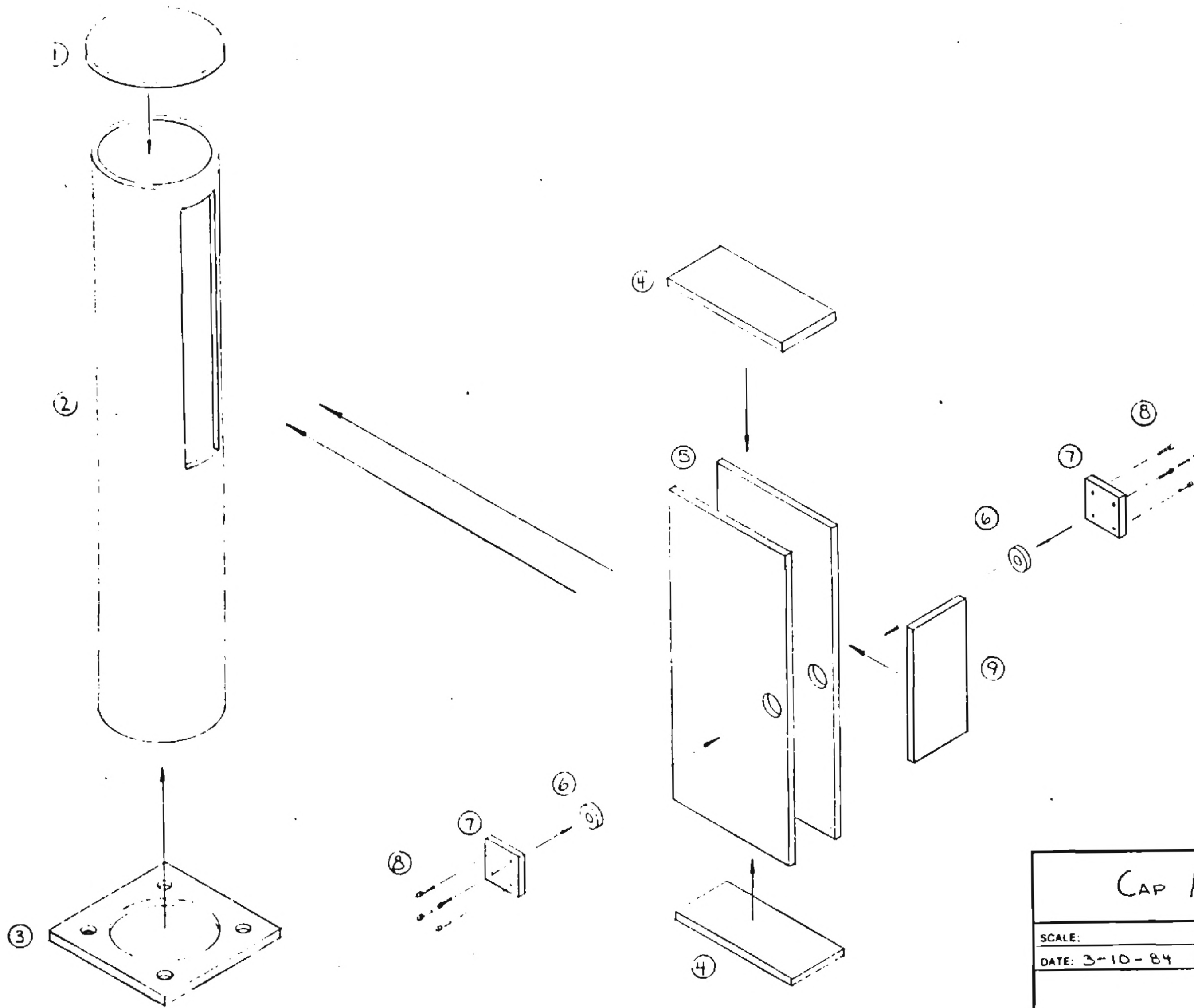
NO. 188A-11X17



	Name	Drawing
(1)	Gland Bolt	GT-13
(2)	Gland Plate	GT-11
(3)	Gland Nut	GT-12
(4)	Gasket	GT-29
(5)	Body and Cap Joint Plate	GT-4
(6)	1" coupling	—
(7)	1" × 5" nipple	—
(8)	1" × 90° elbow	—
(9)	1" × ¾" reducer	—
(10)	¾" × 2" nipple	—
(11)	Body Pipe	GT-1
(12)	Gusset	GT-12
(13)	2" coupling	—
(14)	Body Base	GT-3
(15)	Gasket	GT-29

Body Assembly

SCALE:	APPROVED BY	DRAWN BY
DATE: 3-15-84		
		DRAWING NUMBER GT-26

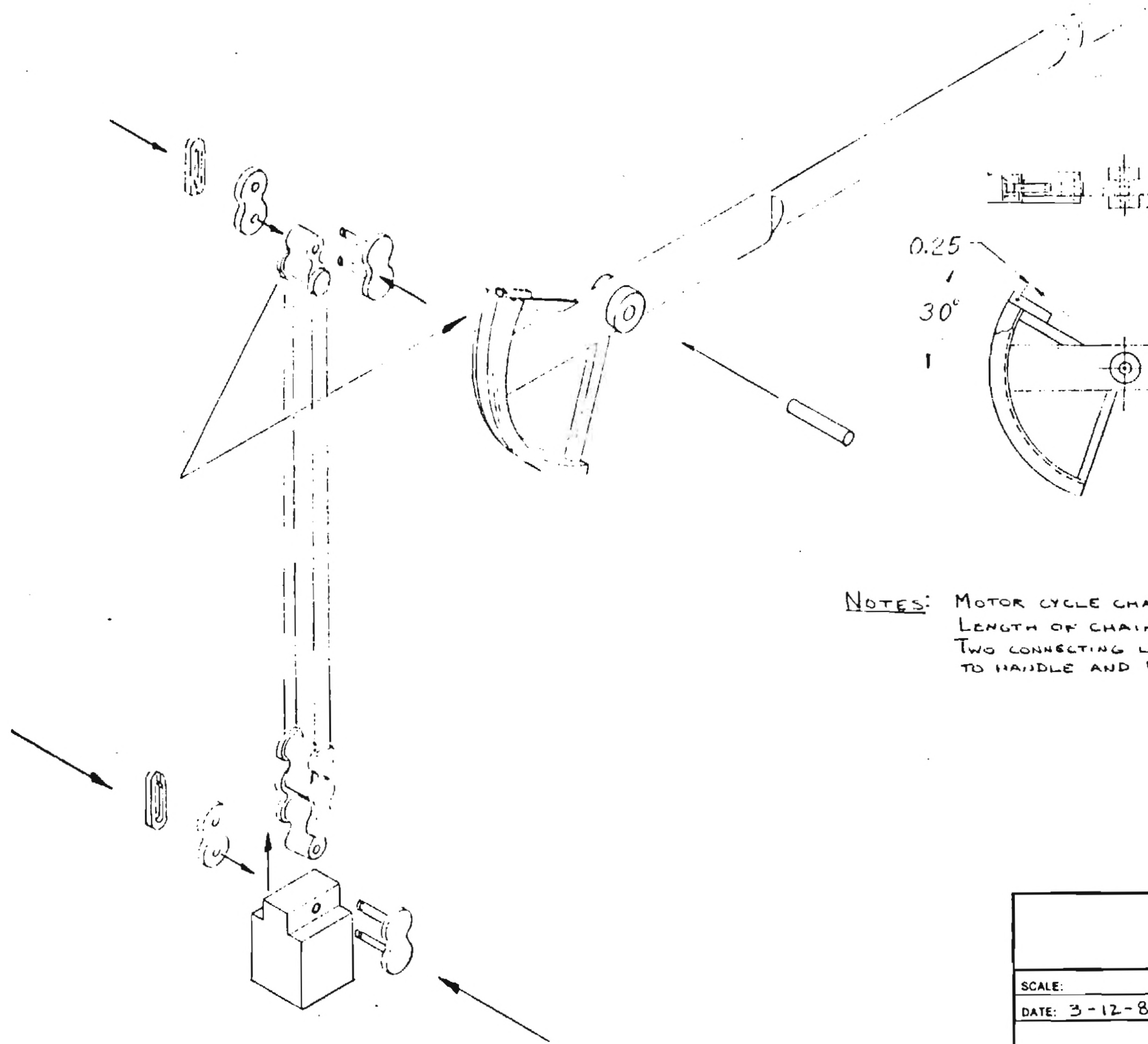


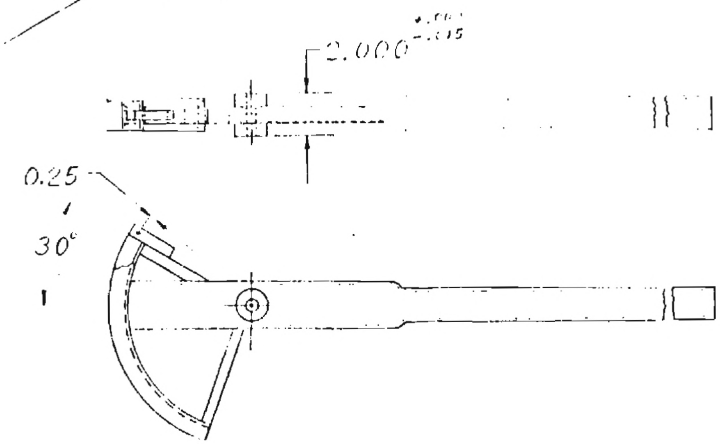
Name	Drawing
(1) Cap Top	GT-6
(2) Cap Pipe.	GT-5
(3) Body and Cap Joint Plate	GT-4
(4) Horizontal Box Guard.	GT-9
(5) Box Plates.	GT-7
(6) Bearings	—
(7) Bearing Cover Plates.	GT-8
(8) 8-32 Allen Screws	—
(9) Vertical Box Guard	GT-10

Cap Assembly

SCALE:	APPROVED BY	DRAWN BY
DATE: 3-10-84		

DRAWING NUMBER
GT-27



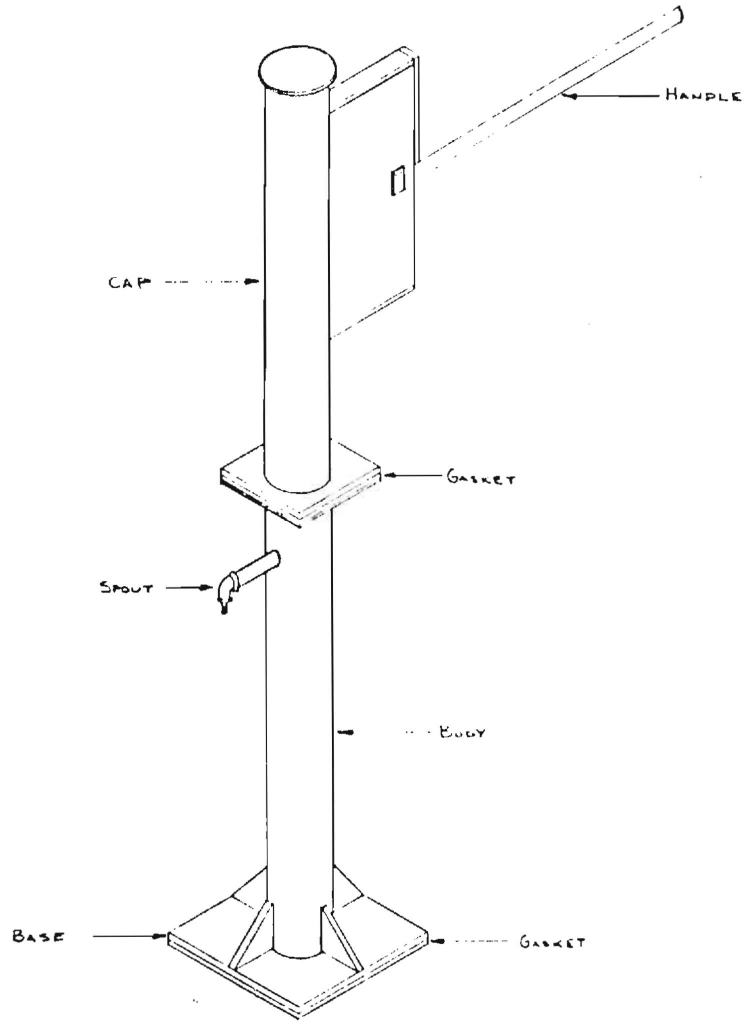


Notes: Motor cycle chain is No. 428 or industrial RC 40.
Length of chain is 14.5".
Two connecting links are used to connect chain to handle and rod coupling.

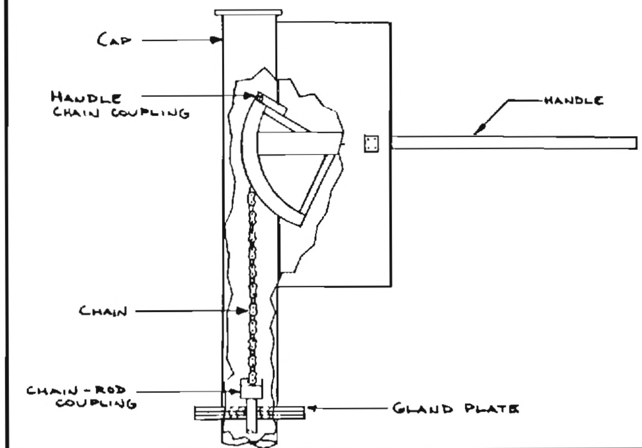
Handle Assembly

SCALE:	APPROVED BY	DRAWN BY
DATE: 3-12-84		
		DRAWING NUMBER GT-28

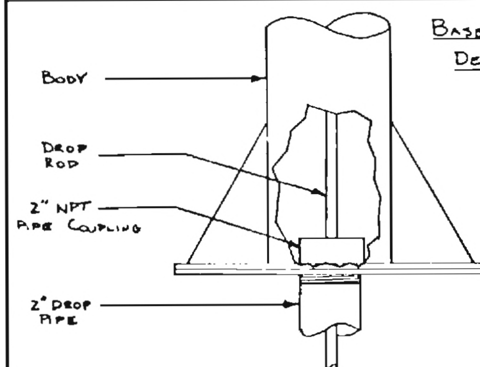
Georgia Tech Steel Hand Pump



Chain Connection Detail



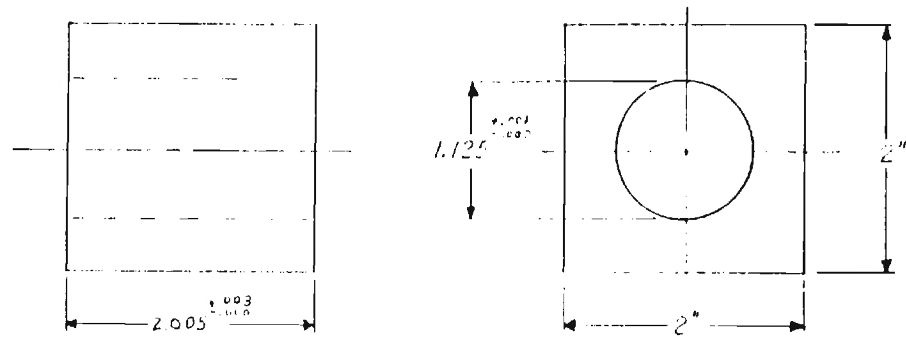
Base - Coupling Detail



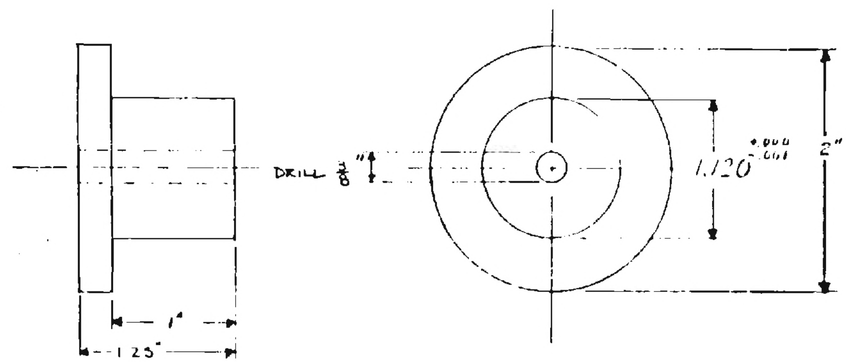
Pump Assembly

SCALE:	APPROVED BY	DRAWN BY
DATE: 3-18-84		
		DRAWING NUMBER GT-29

Spacer

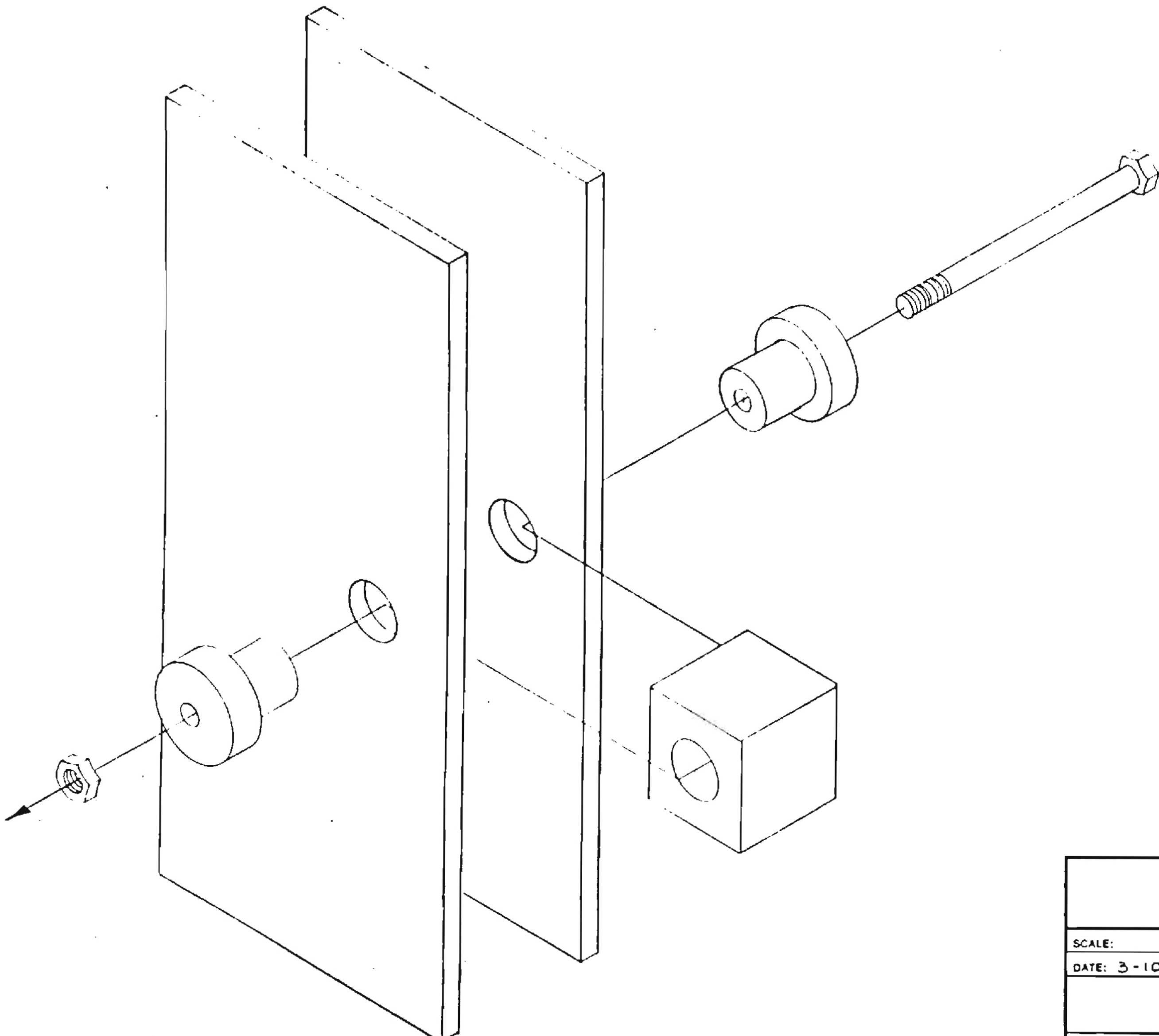


Plugs



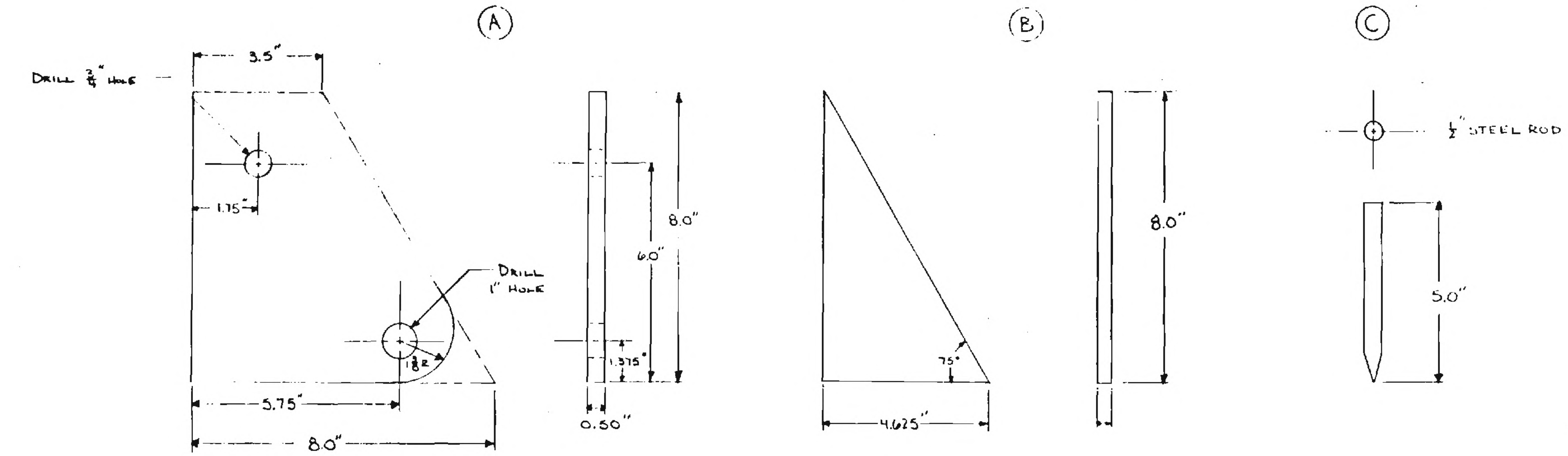
Fixture for Box.

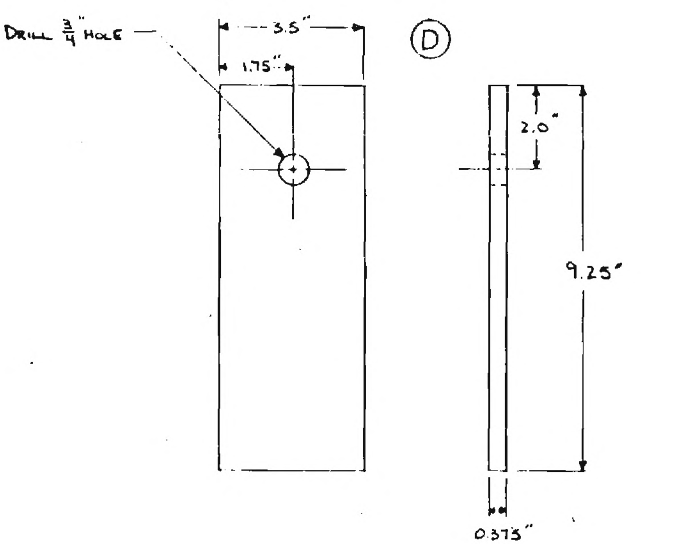
SCALE: 1" = 1"	APPROVED BY	DRAWN BY
DATE: 3-12-84		
MATERIALS: BLACK OR GALVANIZED STEEL		DRAWING NUMBER GT-30

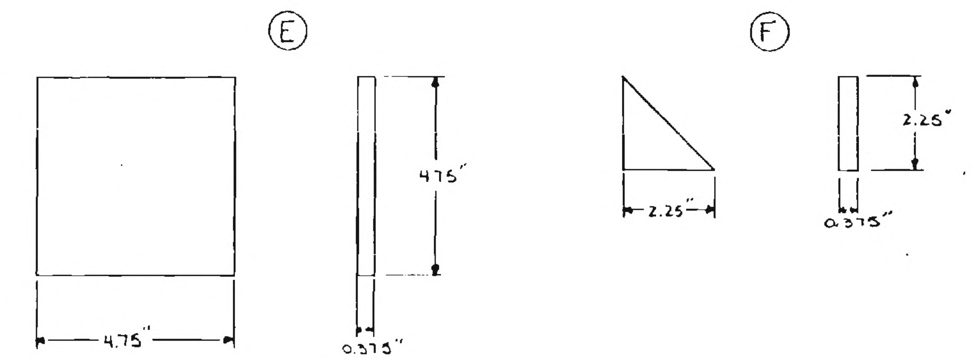


FIXTURE FOR BOX		
SCALE:	APPROVED BY	DRAWN BY
DATE: 3-10-84		
		DRAWING NUMBER GT-31

NO. 1664-11X17





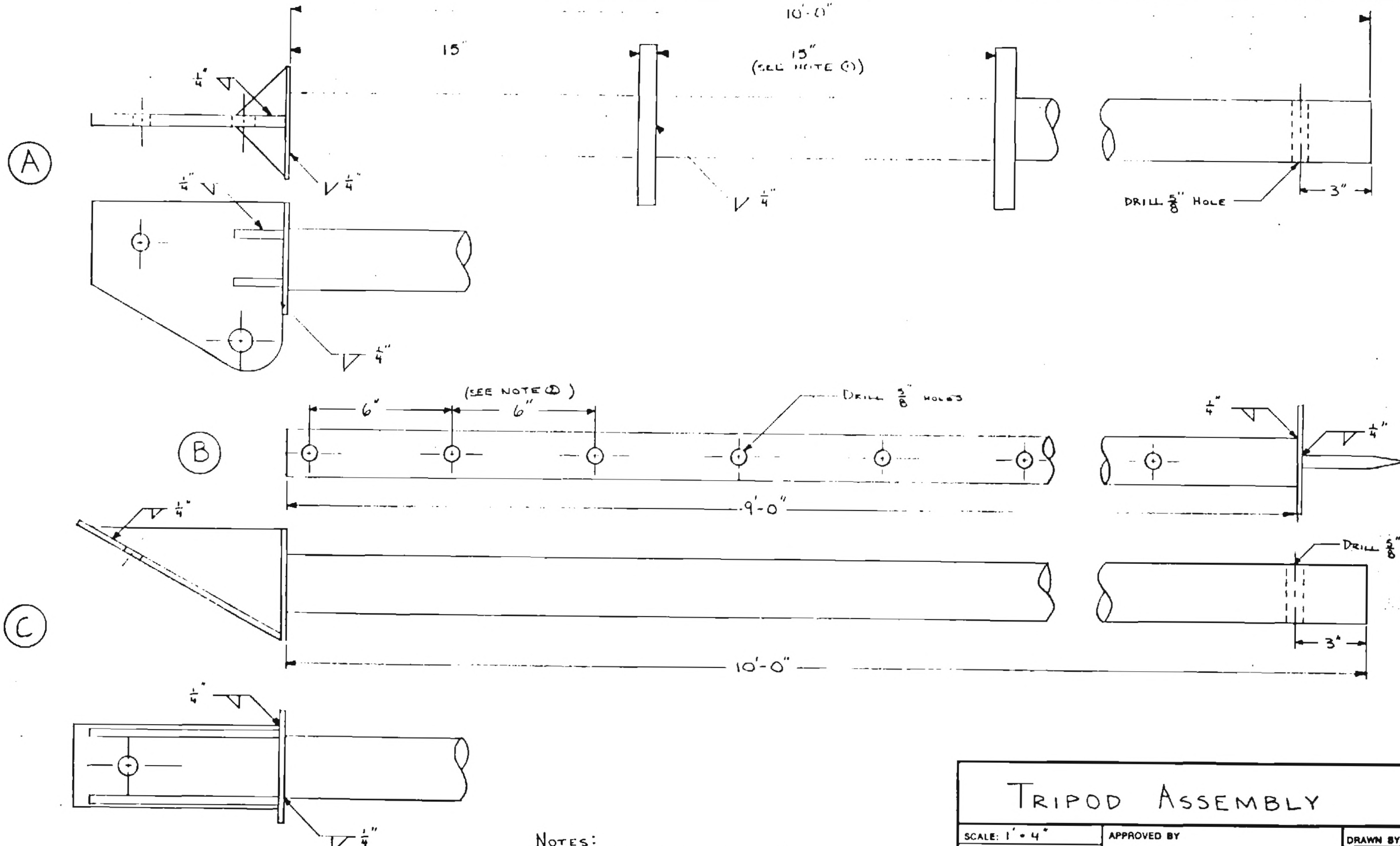


LETTER	PART NAME	MATERIAL
A	MIDDLE LEG BOLTING PLATE	$\frac{1}{2}$" STEEL PLATE
B	SIDE LEG GUSSET	$\frac{3}{8}$" STEEL PLATE
C	GROUND SPIKES	$\frac{1}{2}$" STEEL ROD
D	SIDE LEG BOLTING PLATE	$\frac{3}{8}$" STEEL PLATE
E	PIPE END PLATES	$\frac{3}{8}$" STEEL PLATE
F	MIDDLE LEG BOLTING GUSSETS	$\frac{3}{8}$" STEEL PLATE

TRIPOD COMPONENTS (A) - (F)

SCALE: 1" = 3"	APPROVED BY	DRAWN BY
DATE: 4 - 16 - 84		
		DRAWING NUMBER GT - 32

NO. 185A-11817



NOTES:

① 7 LADDER STEPS 3/4" BAR ON 15" SPACING.

② 16 HOLES - 5/8" DIAM. ON 6" SPACING

TRIPOD ASSEMBLY

SCALE: 1' = 4"	APPROVED BY	DRAWN BY
DATE: 3-1-84		

Ⓐ	2½" SCH 40 GI PIPE – 10' LONG	MIDDLE LEG (QTY:1)
Ⓑ	2" SCH 40 GI PIPE – 9' LONG	INNER LEG (QTY:3)
Ⓒ	2½" SCH 40 GI PIPE – 10' LONG	SIDE LEG (QTY:2)

DRAWING NUMBER

GT-33

APPENDIX C

MANUFACTURERS' DATA SHEETS

MANUFACTURERS' DATA SHEET

Company Name - Equipo Tecnico Industrial, C.A. (ETINCA)

Date Visited - October 25, 1983

Location - Santo Domingo

Number of Employees - 24 foundry, 59 machine shop (when in full production)

Owners - Tobias, Freddie & Juan (brothers)

Staff & Titles

Management - The three brothers. One is a mechanical engineer

Product Lines - Concrete block making machines, concrete mixers, steel trusses, manhole covers, grating.

Comments - This company has made AID pumps in the past but production has now stopped. The foundry is not operating at the present.

Foundry

Melting - Cast iron: 1 cupola, 1 metric ton/hour capacity
1 brass melting furnace

Sand Treatment - Primitive - all done by hand

Pattern Shop - Not evident

Patterns - Wood & aluminum

Molding Method - Wood flasks, hand ram, no match plates

Core Making - Uses sand & sodium silicate but baked rather than CO_2 injected

Materials - Sand from D.R., coke from Columbia thru local dealers, refractory from U.S.

MANUFACTURERS' DATA SHEET (Continued)

Casting Area - 35' x 75' covered shed

Comments - Cupola charge weighed on floor & hoisted to cupola loading level. Pouring crucibles small & crude. Molding flasks very crude & in poor condition.

Machine Shop

Saws	1 power hack, 1 abrasive cut off
Grinders	3 pedestal
Milling Machines	1 very old
Lathes	4 medium
Drills	5 (1 radial)
Shapers	2 small 1 large planer
Arbor Press	3 small 1 large press brake
Heat Treat Facilities	None available - no hardness testing equipment
Work From Drawings	Management team only
Machine Shop Area	4000 ft^2
Comments	Electrical pipe threaders (2); large metalworker; horizontal boring machine; hobbing machine; pyramid turning rolls; sheet metal nibbler; flame cutting table with tracer; 2 flame cutting tables w/o tracer

Overall Observations

This company is a machine shop that added a foundry in order to produce USAID pumps. They seem to have adequate machine shop facilities but their foundry facilities are primitive.

MANUFACTURERS' DATA SHEET

Company Name - Marino Hernandez & Assoc.

Date Visited - October 25, 1983

Location - Santo Domingo

Number of Employees - 8 foundry, 8 machine shop

Owners - Sr. Hernandez

Staff & Titles - Manuel Padron - Shop Foreman

Management -

Product Lines - No product line - replacement parts & general machining

Comments - In process of relocating foundry. Will be in operation in early 1984

Foundry

Melting - 1 cupola - 500 kg/hr cap.

Sand Treatment - Will have muller & screener

Pattern Shop - Some made in own shop and some made by specialty pattern shop

Patterns - Use match plate

Molding Method - hand ram

MANUFACTURERS' DATA SHEET (Continued)

Casting Area -

Comments - 600 m^2 area in new foundry area

Machine Shop

Saws	0
Grinders	2
Milling Machines	2 horizontal
Lathes	3
Drills	3 (1 radial)
Shapers	1
Arbor Press	1 very big
Heat Treat Facilities	No
Work From Drawings	Management team only
Machine Shop Area	1500 ft^2
Comments	Alligator shear; will add additional lathes & power saws at a later date; 3 welding machines.

Overall Observations

This machine shop is not adequate at present to produce 500 pumps per year.

MANUFACTURERS' DATA SHEET

Company Name - Mantenimiento Mecanico Industrial

Date Visited - October 26, 1983

Location - Santo Domingo

Number of Employees - 6

Owners - Ing. Tomas Batista

Staff & Titles -

Management - Owner managed

Product Lines - No product line. This company produces injection molding tooling to customer specifications

Comments - Small precision machine shop only.

Foundry

Melting -

Sand Treatment -

Pattern Shop -

Patterns -

Molding Method -

MANUFACTURERS' DATA SHEET (Continued)

Casting Area -

Comments -

Machine Shop

Saws

Grinders

Milling Machines

Lathes

Drills

Shapers

Arbor Press

Heat Treat Facilities

Work From Drawings

Machine Shop Area

Comments

Overall Observations

This company could not produce cast iron pumps in any significant quantity.

MANUFACTURERS' DATA SHEET

Company Name - Talleres Pichardo & Co.

Date Visited - October 26, 1983

Location - Santo Domingo

Number of Employees - 75 +

Owners - Sr. Hector B. Pichardo

Staff & Titles - President is owner

Management - Owner managed

Product Lines - Gasoline & diesel engine rebuilders

Comments - This is a very specialized facility dedicated to engine rebuilding with precision equipment

Foundry

Melting -

Sand Treatment -

Pattern Shop -

Patterns -

Molding Method -

MANUFACTURERS' DATA SHEET (Continued)

Casting Area -

Comments -

Machine Shop - Many very specialized pieces of precision equipment

Saws

Grinders

Milling Machines

Lathes

Drills

Shapers

Arbor Press

Heat Treat Facilities

Work From Drawings

Machine Shop Area

Comments

Overall Observations

This company's present line of business would not be compatible with cast iron pump production.

<u>MANUFACTURERS' DATA SHEET</u>

Company Name - Senra Tool & Die, S.A.

Date Visited - October 26, 1983

Location - Santo Domingo

Number of Employees - 50

Owners - Ing. Cesar Senra

Staff & Titles -

Management - Owner managed

Product Lines - Tools & dies, replacement parts to order, metal fabrications to order, punch press sheet metal parts.

Comments - This company has 3 production areas: machine shop, fab shop and press room.

<u>Foundry</u>

Melting -

Sand Treatment -

Pattern Shop -

Patterns -

Molding Method -

MANUFACTURERS' DATA SHEET (Continued)

Casting Area -

Comments -

Machine Shop

Saws	2 power hack
Grinders	2 pedestal, 1 cylindrical, 1 surface
Milling Machines	9 (1 universal, 2 horizontal & 6 vertical)
Lathes	6 (1 large & 5 medium)
Drills	4
Shapers	2
Arbor Press	1
Heat Treat Facilities	yes
Work From Drawings	yes
Machine Shop Area	2000 ft^2
Comments	Also has 2 shear, 8' press brake, horizontal cold-header, spot welder, 3 electric welding machines, 15 mechanical presses and batch brazing facilities.

Overall Observations

Excellent machine shop capable of producing over 500 cast iron hand pumps per year to specification. Castings must be procured elsewhere, however.

MANUFACTURERS' DATA SHEET

Company Name - Cedeno Industrial, S.A.

Date Visited - November 17, 1983

Location - Santo Domingo

Number of Employees - 30

Owners - Jose Cedeno, Pres.

Staff & Titles -

Management - Cedeno is president and technical director. He seems to provide all of the major management.

Product Lines - General foundry, machine repair, equipment fab. etc. Block making machines, concrete mixers.

Comments - According to owner, has built own line of pumps, and 2 or 3 of them have been installed. Will sell through ferraterias (hardware stores) on consignment.

Foundry

Melting - Cupola 1 1/2 ton/hr

Sand Treatment - Crude hand screen

Pattern Shop - No

Patterns - Makes own patterns

Molding Method - Hand ram steel flasks; makes cores from sand and molasses

MANUFACTURERS' DATA SHEET (Continued)

Casting Area -

Comments - Presently has complete patterns for AID design pumps. Now makes gears, railroad brake shoes and centrifugal pumps. Casting quality is good.

Machine Shop

Saws	2 power hack
Grinders	3 pedestal, 1 surface
Milling Machines	1
Lathes	3 large
Drills	2 large 1 small
Shapers	1 planer
Arbor Press	1 hydraulic
Heat Treat Facilities	None
Work From Drawings	Yes
Machine Shop Area	800 ft^2 fab area 1000 ft^2
Comments	4 or 5 persons can work from English drawings. Facilities are crude but effective. 1 iron worker.

Overall Observations

This company could produce the AID design hand pump in quantities over 500 per year if they can find someone to harden the pins and bushings.

MANUFACTURERS' DATA SHEET

Company Name - DIMECO (Diseno Mecanico y Construcciones, C.A.)

Date Visited - October 26, 1983

Location - Santo Domingo

Number of Employees - 15

Owners - Sr. Jose Cedeno

Staff & Titles - Owner/President

Management - Owner/Manager Shop Foreman

Product Lines - Plastic injection molds, dies, precision machine parts

Comments -

Foundry

Melting -

Sand Treatment -

Pattern Shop -

Patterns -

Molding Method -

MANUFACTURERS' DATA SHEET (Continued)

Casting Area -

Comments -

Machine Shop

Saws	2 (1 regular hack and 1 large power hack)
Grinders	2 pedestal, 2 precision (vent & horizontal), 1 cylindrical
Milling Machines	1 large universal, 4 vertical, 1 tracing mill
Lathes	6 (4 large, 1 regular, 1 small)
Drills	5
Shapers	2 Also 1 planer
Arbor Press	1
Heat Treat Facilities	Yes
Work From Drawings	Yes
Machine Shop Area	4000 ft^2 +
Comments	Has hardness tester, 4 vertical punch presses, heat treat furnace, 10' shear, 10' apron brake, "C" frame nibbler, auto screw machine, good tool room with 1 man issuing all tools

Overall Observations

This company could produce over 500 AID design pumps per year but they would have to obtain castings from other companies.

MANUFACTURERS' DATA SHEET

Company Name - Fundicion "San Pedro"

Date Visited - October 25, 1983

Location - Santo Domingo

Number of Employees - 3

Owners - Sr. Jesus Nunez Cabrera

Staff & Titles -

Management - Owner managed

Product Lines - Manhole covers, grating & fences

Comments - Very small operation

Foundry

Melting - Cupola (very small)

Sand Treatment - None; Hand screened

Pattern Shop - None

Patterns - Wood

Molding Method - Hand ram

MANUFACTURERS' DATA SHEET (Continued)

Casting Area - 1000 ft^2

Comments - Very marginal foundry - poor quality iron

Machine Shop

Saws

Grinders

Milling Machines

Lathes

Drills

Shapers

Arbor Press

Heat Treat Facilities

Work From Drawings

Machine Shop Area

Comments

Overall Observations

Not able to produce minimal quality casting required for AID pump.

MANUFACTURERS' DATA SHEET

Company Name - Fundicion Alamo, C.A.

Date Visited - October 25, 1983

Location - Santo Domingo

Number of Employees - 16 full-time; 42 part-time

Owners - Erick Lopez

Staff & Titles -

Management - Owner managed

Product Lines - Gray iron castings to customer specs, manhole covers, gratings, railroad brake shoes, brass & aluminum plaques

Comments -

Foundry

Melting - 2 cupolas each 1 1/2 ton per hour cap.

Sand Treatment - Primitive - Hand screen only

Pattern Shop - Well equipped

Patterns - Wood & aluminum

Molding Method - Match plate with jolt squeeze

MANUFACTURERS' DATA SHEET (Continued)

Casting Area - 5000 ft^2

Comments - Good foundry layout

Machine Shop

Saws

Grinders

Milling Machines

Lathes

Drills

Shapers

Arbor Press

Heat Treat Facilities

Work From Drawings

Machine Shop Area

Comments

Overall Observations

This would be a good foundry to produce castings for machine shops with no foundry.

MANUFACTURERS' DATA SHEET

Company Name - Fundicion Reyes

Date Visited - October 25, 1983

Location - Santo Domingo

Number of Employees - 45

Owners - Sr. Reyes

Staff & Titles -

Management -

Product Lines - Aluminum & gray iron castings.

Comments -

Foundry

Melting - Cupola for iron and oil fired in-ground furnace for aluminum

Sand Treatment - Hand screen

Pattern Shop - None observed

Patterns - Wood

Molding Method - Hand ram

MANUFACTURERS' DATA SHEET (Continued)

Casting Area - 1000 ft^2

Comments - At the time this company was visited they were only casting aluminum. The gray iron castings they had produced previously were medium quality simple shapes.

Machine Shop

Saws

Grinders

Milling Machines

Lathes

Drills

Shapers

Arbor Press

Heat Treat Facilities

Work From Drawings

Machine Shop Area

Comments

Overall Observations

This company could probably produce acceptable castings for AID pump components but they have no machining capability.